

AERONAUTICS

XC-142A TILT WING VTOL TRANSPORT

HOVERING TO 355 KNOTS (400MPH)
4 TURBOPROP ENGINES
HORSEPOWER 2850 EACH



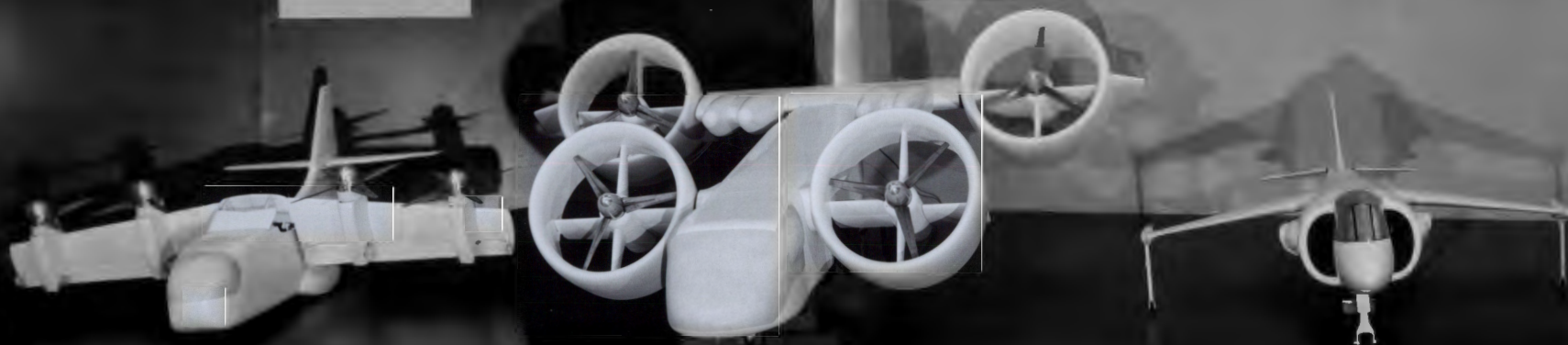
X-22A TILTING DUCTED FANS VTOL TRANSPORT

HOVERING TO 355 KNOTS (400MPH)
4 TURBO-SHAFT ENGINES
HORSEPOWER 1250 EACH



P-1127 DEFLECTED JET VTOL STRIKE FIGHTER

HOVERING TO 640 KNOTS (700MPH)
ONE TURBOFAN ENGINE
RATED AT 15000 LBS OF THRUST



BOUNDARY LAYER CONTROL SYSTEM



BOUNDARY LAYER CONTROL

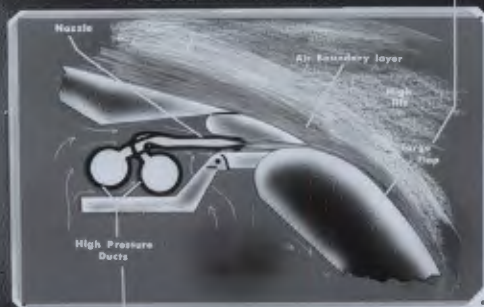
DUAL ENGINE BLEED PORTS

PRIMARY NOZZLES

DUCTS

FLAP

WITH BLC
LANDING AT 90 MPH.



JET ENGINE

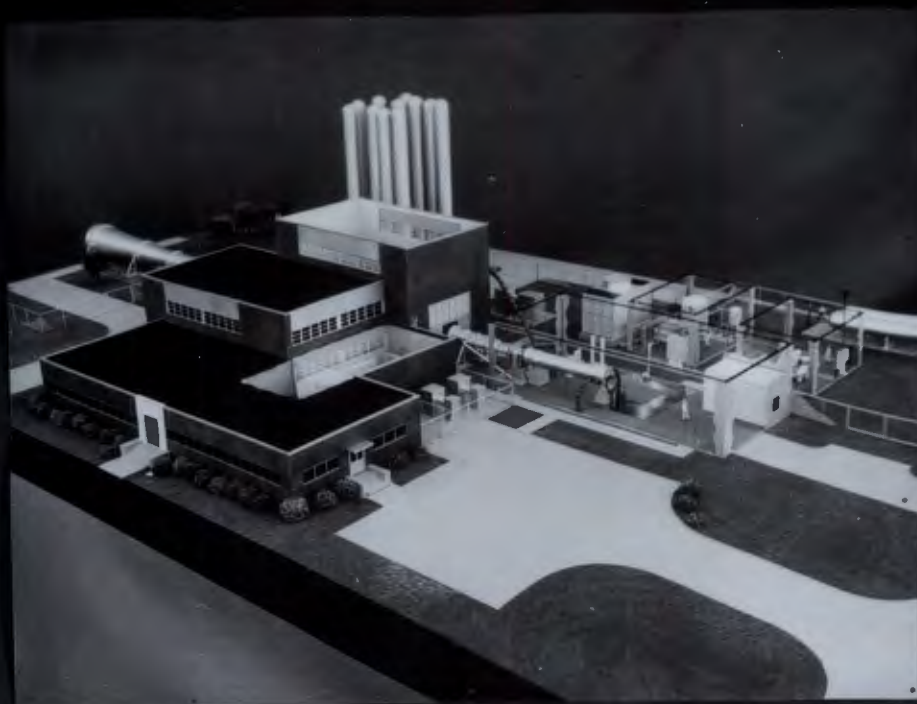
Compressed Air 100 lb Per sq. in.

to nozzles

High Pressure Air

NORMAL
LANDING AT 138 MPH.





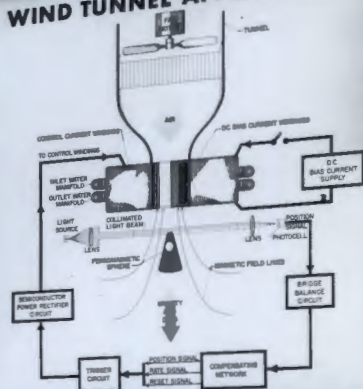
8 FOOT HIGH TEMPERATURE
STRUCTURES TUNNEL



16 FOOT TRANSONIC TUNNEL

MAGNETIC SUSPENSION RESEARCH

WIND TUNNEL APPLICATION



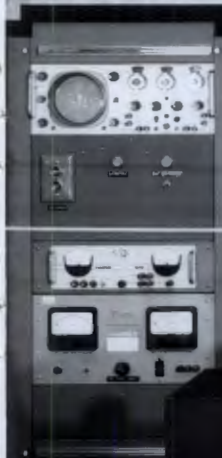
THIS EXHIBIT REPRESENTS
THE MOST RECENT APPROACH
TO THE ACHIEVEMENT OF THE
GOAL OF MAGNETIC SUSPENSION
OF MODELS IN WIND
TUNNELS

WIND TUNNEL APPLICATION

- 1-ELIMINATION OF AERODYNAMIC INTERFERENCE FROM MECHANICAL SUPPORT STRUCTURES.
- 2-PERMITS REPRODUCTION OF TRUE AERODYNAMIC BODY SHAPE.
- 3-ALLOWS TRUE BODY FREEDOMS.
- 4-PERMITS BETTER SIMULATION OF INTERNAL ENGINE AND DUCTING ARRANGEMENT.

WIND TUNNEL

MAGNET COIL





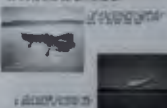
STRUCTURAL DYNAMICS

HYPERSONIC RESEARCH



FLIGHT RESEARCH CENTER
EDWARDS CALIFORNIA

RECOVERY SYSTEMS RESEARCH



HYPERSONIC RESEARCH



THE X-15 "L" JETTISONING ITS EXTERNAL PROPELLANT TANKS AFTER THEY ARE EMPTY, ACCELERATES TO SUSTAINED HIGH SPEED TO FLIGHT TEST VARIOUS AIR-BREATHING PROPULSION SYSTEMS.



SHOCK WAVES FORM IN THE EXHAUST PLUME OF THE ROCKET ENGINE AS THE X-15 BEGINS TO CLIMB UPWARD.



WITH THE ROCKET ENGINE ALREADY FIRED AND ITS LIGHTER AT 154, THE 3000 POUND X-15 BOOBS AWAY FROM THE B-52.



ENGINEERS AND TECHNICIANS MONITOR THE FLIGHT FROM THE NASA CONTROL ROOM.



CLIMBING THROUGH 200,000 FEET OUTSIDE OF THE FILTERING EFFECTS OF EARTH'S ATMOSPHERE, CLAMHELL DOORS OPEN AND CAMERAS BEGIN TO PHOTOGRAPH THE STARS.



TEN MINUTES LATER AND 250 MILES FROM LAUNCH, THE X-15 EXTENDS ITS LANDING GEAR IN PREPARATION FOR LANDING.



FLIGHT COMPLETE, THE B-52 AND TWO F-104 CHASE AIRCRAFT DIP LOW OVER THE X-15 IN SALUTE.

RCH

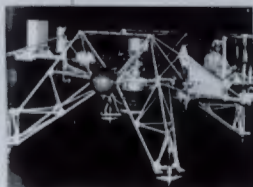
RECOVERY SYSTEMS RESEARCH

LUNAR LANDING RESEARCH



THE LUNAR LANDING RESEARCH VEHICLE CLIMBS TO 1000 FEET WHERE IT BEGINS THE FINAL PHASE OF THE LUNAR LANDING MANEUVER.

THE LUNAR LANDING RESEARCH VEHICLE STANDS SLIGHTLY MORE THAN 10 FEET TALL WITH A LEE SPREAD OF 30 FEET. THE JET ENGINE IN THE CENTER COUNTER BALANCES SA'S OF THE VEHICLE'S WEIGHT WHICH SIMULATES ACTUAL LUNAR FLIGHT CONDITIONS.



PREPARING TO TRANSLATE HORIZONTAL DISTANCE, THE LUNAR LANDING RESEARCH VEHICLE USES SMALL ROCKET MOTORS TO CHANGE THE DIRECTION OF MOVEMENT.



PARAGLIDER RESEARCH



THE PARASEV IS CONTROLLED BY TILTING THE FLEXIBLE WING FROM SIDE TO SIDE AND/OR UP AND DOWN.



DURING GLIDE FLIGHT THE PARASEV HAS A FORWARD SPEED OF ABOUT 70 MILES PER HOUR. THE DESCENT FROM 10000 FEET TAKES ABOUT 3 MINUTES.



THE PARASEV (PARAGLIDER RESEARCH VEHICLE) IS TOWED TO AN ALTITUDE OF 10000 FEET AND THEN FLIES BACK TO THE GROUND. THE LOW SPEED FLIGHT CAPABILITY OF THE PARASEV IS EVALUATED BY THE FLIGHT PROGRAM EVALUATES ROCKETED WING SYSTEM.

LIFTING BODY RESEARCH



A HEAVY WEIGHT VERSION OF THE LIFTING BODY IS CARRIED ALOFT BY A B-52 FOR FREE FLIGHT BACK TO THE LAKE BED.



THE M-2 LIFTING BODY IS TOWED BY A C-47 TO AN ALTITUDE OF ABOUT 18000 FEET FOR RELEASE AND GLIDE FLIGHT BACK TO THE DRY LAKE BED.



THE M-2 BEGINS ITS LANDING FLARE AT ABOUT 300 FEET AND TOUCHES DOWN AT APPROXIMATELY 80 MILES PER HOUR.





STRUCTURAL DYNAMICS



THE X-15 "2" JETTED
SUSTAINED HIGH SPEED

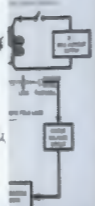


ENGINEERS AND TECH
THE FLIGHT FROM THE X



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CH

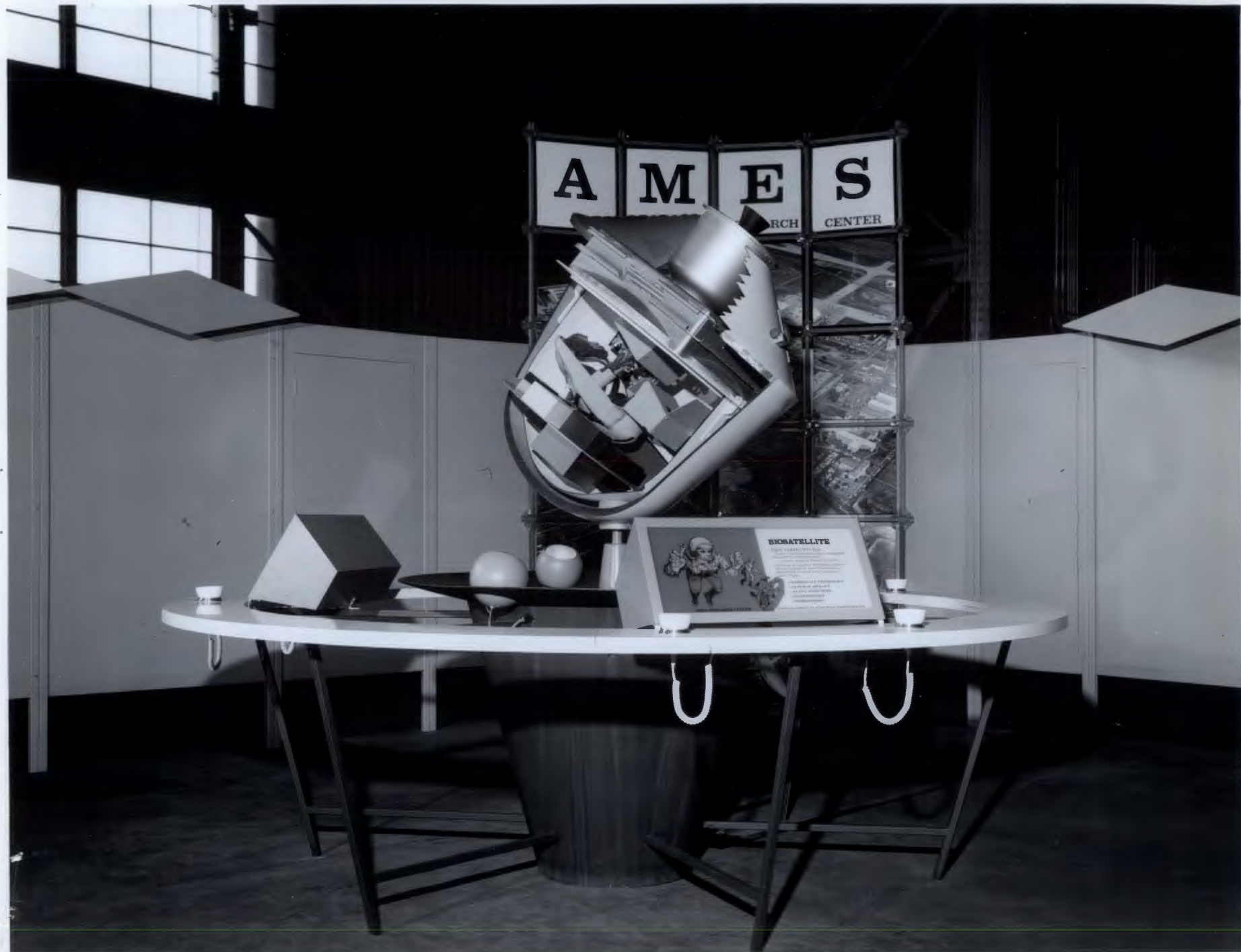
LICATION



RESENTS
APPROACH
ENT OF THE
SUSPENS-
IN WIND



NASA
L-64-4891



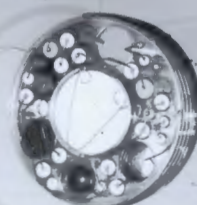
BIOTECHNOLOGY
Physiological Monitoring



energy



transducer



transmitter
(microminiature)

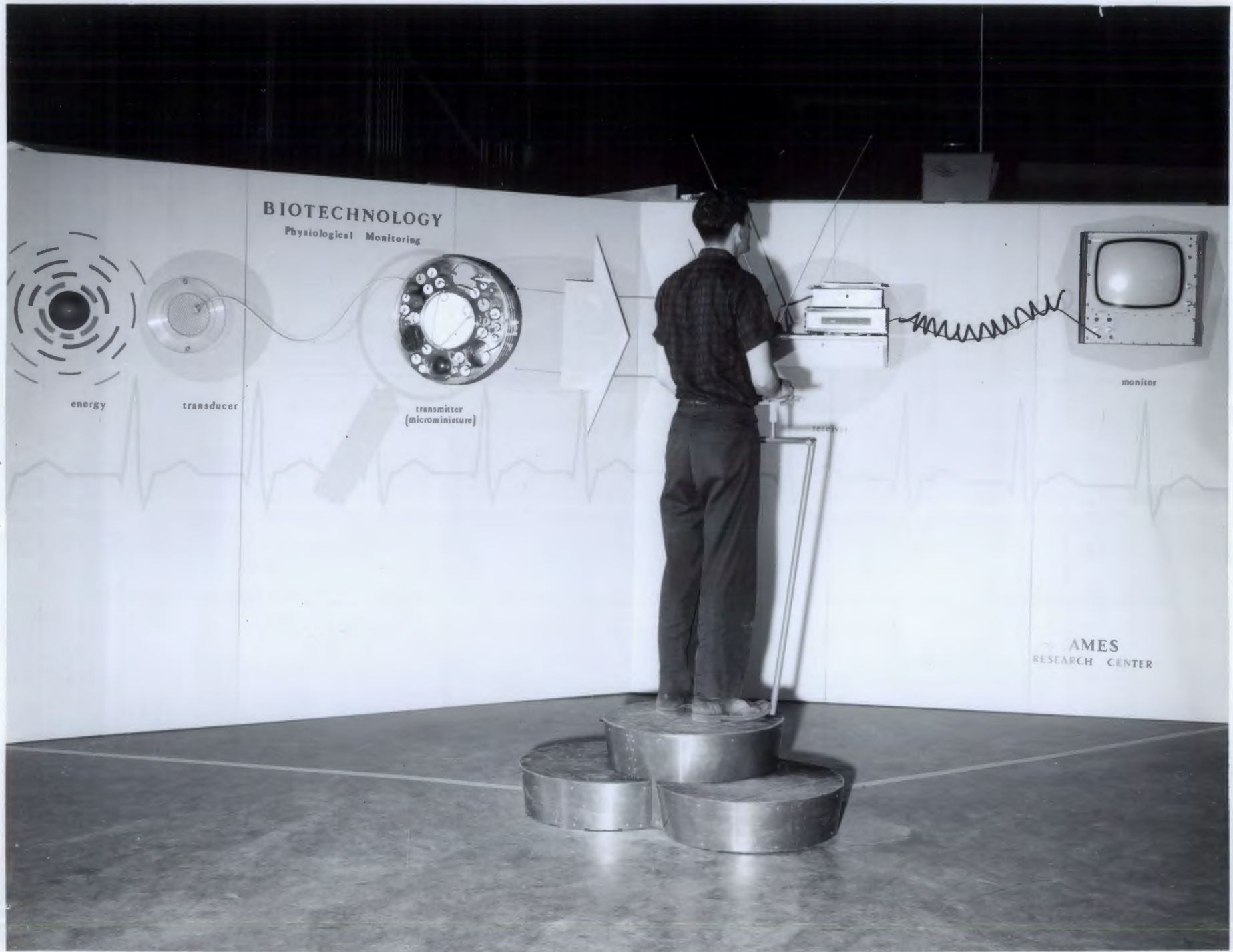


receiver

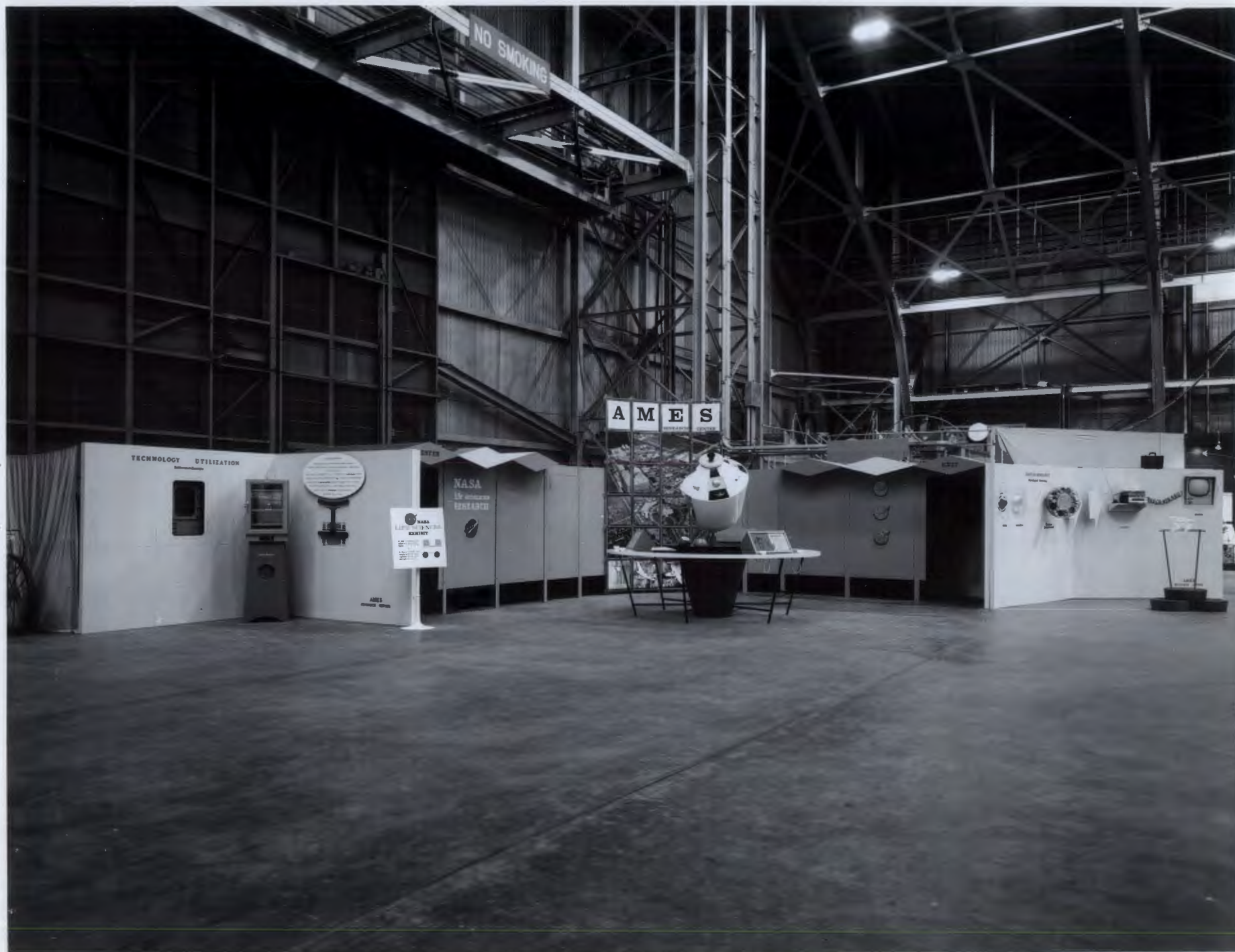


monitor

AMES
RESEARCH CENTER



NASA
L-64-4894



TECHNOLOGY UTILIZATION

Ballistocardioscope



BALLISTOCARDIOSCOPE

Techniques developed to space research have unexpected applications to other fields. Ballistocardiographs, which measure a mechanical impulse as electrical energy, was originally developed at NASA's Ames Research Center.

It is so sensitive that it can be easily adapted to measure heart rate in man. It is so sensitive that it can be easily adapted to measure heart rate in man. It is so sensitive that it can be easily adapted to measure heart rate in man.

The Ames Research Center is currently investigating the possibility of this space research in a research and for investigating the effects of space conditions on the human body.

AMES
RESEARCH CENTER



PROJECT FIRE

FLIGHT REENTRY RESEARCH AT 25000 MPH

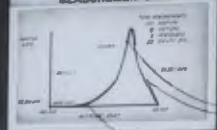
PROJECT FIRE TRAJECTORY



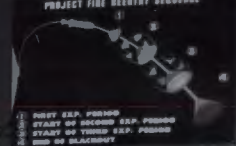
OBJECTIVES

- EXTEND REENTRY TECHNOLOGY TO LUNAR AND PLANETARY RETURN SPEEDS
- FIRST DEFINITIVE FLIGHT DEMONSTRATION OF HEATING ENVIRONMENT
- REENTRY HEATING
- CONVECTIVE HEATING

MEASUREMENTS



PROJECT FIRE REENTRY SEQUENCE



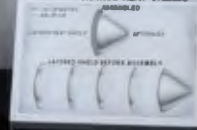
REENTRY PACKAGE TELEMETRY RECORD



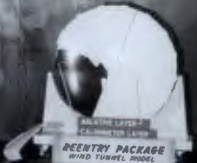
PROJECT FIRE REENTRY



REENTRY PACKAGE HEAT SHIELDS



REENTRY PACKAGE WIND TUNNEL MODEL



PROTOTYPE REENTRY PACKAGE



PROJECT FIRE

FLIGHT REENTRY RESEARCH AT 25000 MPH

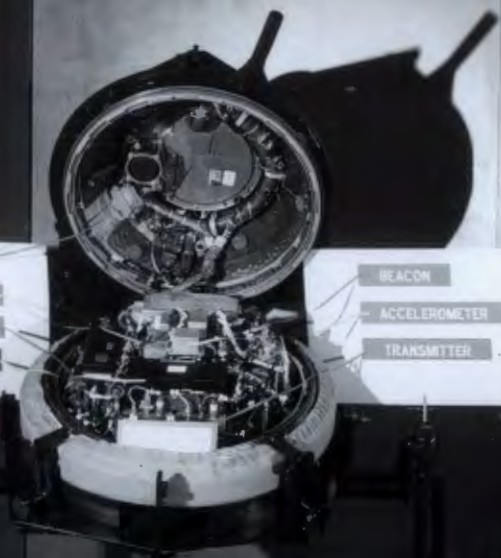


PROJECT FIRE TRAJECTORY



- EXTENDED TO L... RETU...
- FIRST DETE... ENVIR...

The primary heating measured 25,000 mph and the usefulness of ground tests in the form of the hot gas were to be measured radiant heating to In addition, the signals from the space the radio attenuated velocities and altitude. On April 14, consisting of an Atlas age and reentry package here, was launched analysis of the rest that the majority of

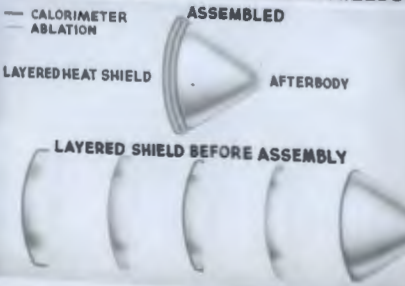


COOLER
GYRO PACKAGE
TOTAL RADIOMETER
TAPE RECORDER

BEACON
ACCELEROMETER
TRANSMITTER

PROTOTYPE
REENTRY

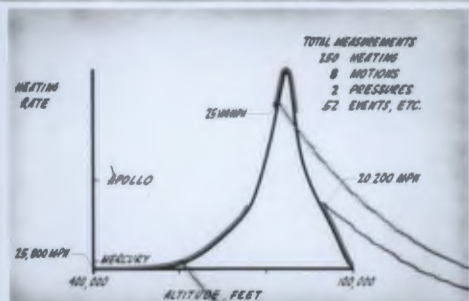
REENTRY PACKAGE HEAT SHIELDS



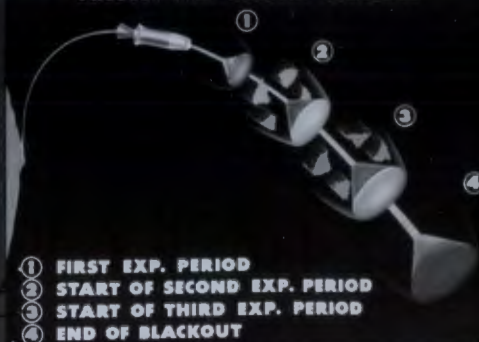
OBJECTIVES

- EXTEND REENTRY TECHNOLOGY TO LUNAR AND PLANETARY RETURN SPEEDS
- FIRST DEFINITIVE FLIGHT DETERMINATION OF HEATING ENVIRONMENT
 - RADIATIVE HEATING
 - CONVECTIVE HEATING

MEASUREMENTS



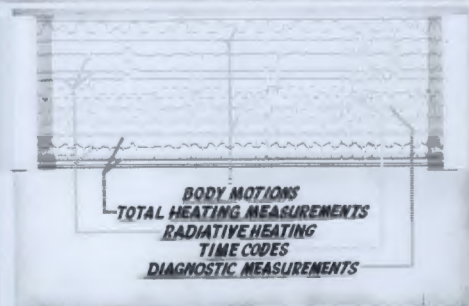
PROJECT FIRE REENTRY SEQUENCE



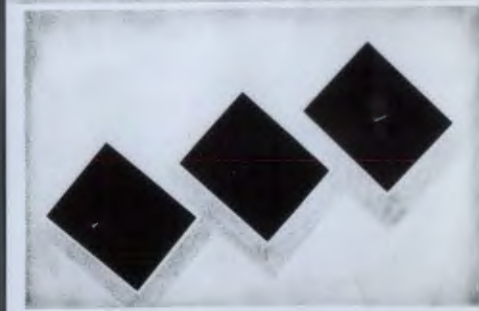
The primary objective of Project Fire was to provide heating measurements during an actual reentry flight at 25,000 mph and in so doing to validate and expand the usefulness of ground facilities and theoretical methods used in studies of reentry heating. Specifically, temperatures in the forebody and afterbody and radiant energy from the hot gas cap surrounding the reentry package were to be measured, thus defining the contribution of radiant heating to the total heat load on the spacecraft. In addition, the extent and duration of loss of radio signals from the spacecraft were to be measured to define the radio attenuation problem for blunt bodies at these velocities and altitudes.

On April 14, 1964, the Project Fire vehicle, consisting of an Atlas D launch vehicle and a velocity package and reentry package similar to the prototypes displayed here, was launched from Cape Kennedy. Preliminary analysis of the results obtained from this flight indicate that the majority of the mission goals were attained.

REENTRY PACKAGE TELEMETRY RECORD



PROJECT FIRE REENTRY

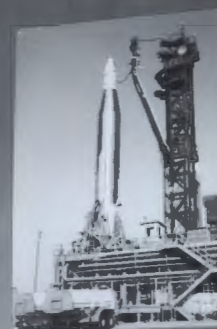




COOLER
GYRO PACKAGE
TOTAL RADOMETER
TAPE RECORDER

BEACON
ACCELEROMETER
TRANSMITTER

PROTOTYPE
REENTRY
PACKAGE



FLIGHT

TRAILBLAZER II

REENTRY PHYSICS RESEARCH

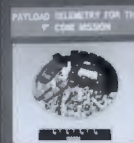
VEHICLE



UNIQUE TRAJECTORY WHICH BRINGS THE REENTRY OF THE VEHICLE BACK TOWARD THE LAUNCH AREA AND GROUND BASED DISTRIBUTION

ENLARGED: THE LINDSAY PHOTO
OF THE LINDSAY GARDEN WHICH
STILL SHOWS THE REMAINING
WALLS

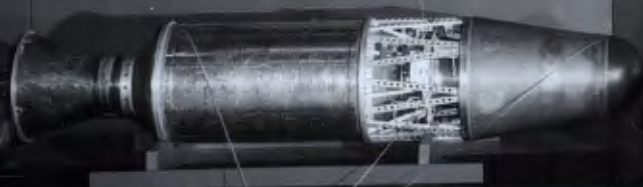
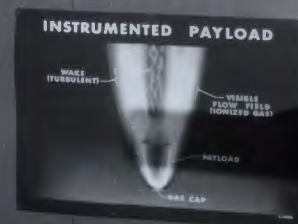
OBJECTIVES



*DAVID LINDGREN AND
LIVING MEMORIES
OF TROUBLED LAND
BASED UPON*

**SUNBELT EDUCATION
INTEGRITY ACADEMY -
MENTAL HYGIENE
LAW ENFORCE CAMPAIGN**

**SAFETY AND HEALTH
EDUCATION: INTERMEDIATE
ACHIEVEMENTS AND
AN IMPROVED UNDER-
STANDING OF THE
PROBLEM.**



PAYLOADS

TELEMETRY

PASSIVE

INSTRUMENTED

DIGITAL TELIMETER UNIT WITH
DATA STORAGE CAPABILITY





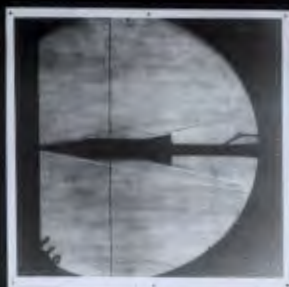
NASA

L-64-4831





JET PLUMING



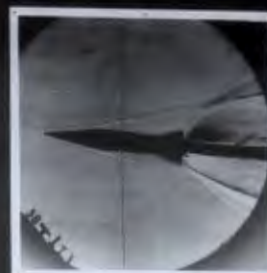
NO JET PLUME
FLOW ATTACHED TO FLARE
STABLE AT ALL ANGLES



SIMULATED ALTITUDE 180,000 FT.
STATIC PRESSURE RATIO
(P/P_∞)=100
FLOW ATTACHED TO FLARE
STABLE AT ALL ANGLES



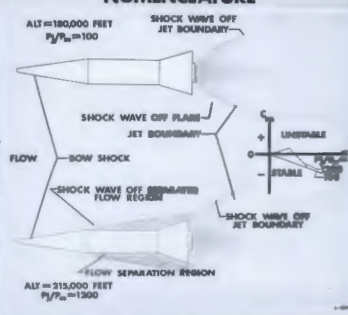
SIMULATED ALTITUDE 25,000 FT.
STATIC PRESSURE RATIO 1200
FLOW SEPARATION OVER FLARE
UNSTABLE AT SMALL ANGLES



SIMULATED ALTITUDE 715,000 FT.
STATIC PRESSURE RATIO 1200
FLOW ATTACHED TO DOWNWARD
SIDE OF FLARE STABLE AT
APPROXIMATELY 5° AND LARGER
ANGLES

2 HYPERSONIC FLOW FIELD WITH AND WITHOUT ROCKET JET PLUME

1 FLOW FIELD AND VEHICLE STABILITY NOMENCLATURE



AERODYNAMIC VEHICLE STABILITY PROBLEM

WIND TUNNEL MODELS

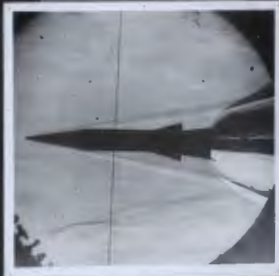


3 DEVICES STUDIED TO REDUCE VEHICLE INSTABILITY

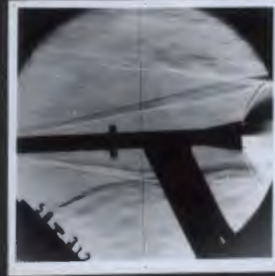
DEVICE: BICONICAL FLARE
RESULT: NEGATIVE



DEVICE: ROCKET NOZZLE EXIT
DISPLACED DOWNSTREAM
RESULT: NEGATIVE



DEVICE: BOUNDARY LAYER
VORTEX GENERATOR
RESULT: NEGATIVE



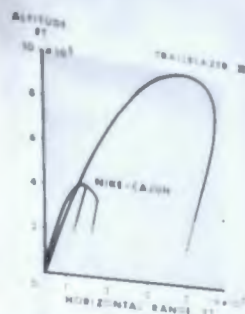
DEVICE: EXTENDABLE FLAPS
RESULT: POSITIVE



RESEARCH IN

LE TRAJECTORIES

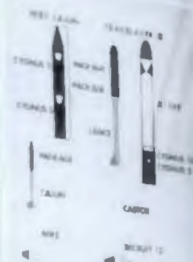
VEHICLE TRAJECTORIES



PHYSICAL THEORY
OF METEORS

- UNKNOWN'S:**
- 1 INITIAL MASS
 - 2 DENSITY
 - 3 SHAPE
 - 4 DRAG COEFFICIENT
 - 5 HEAT TRANSFER COEFFICIENT
- OBSERVATIONAL DATA**
- 1 VELOCITY
 - 2 DECELERATION
 - 3 INTENSITY
 - 4 RADIO ECHO
 - 5 SPECTRA
- CRITICAL CONSTANTS**
- 1 LUNOSITY EFFICIENCIES
 - 2 IONIZATION EFFICIENCIES

METEOR VEHICLES



NIKE CAJUN
ARCAS
HASP DART

METEOR PE 3000

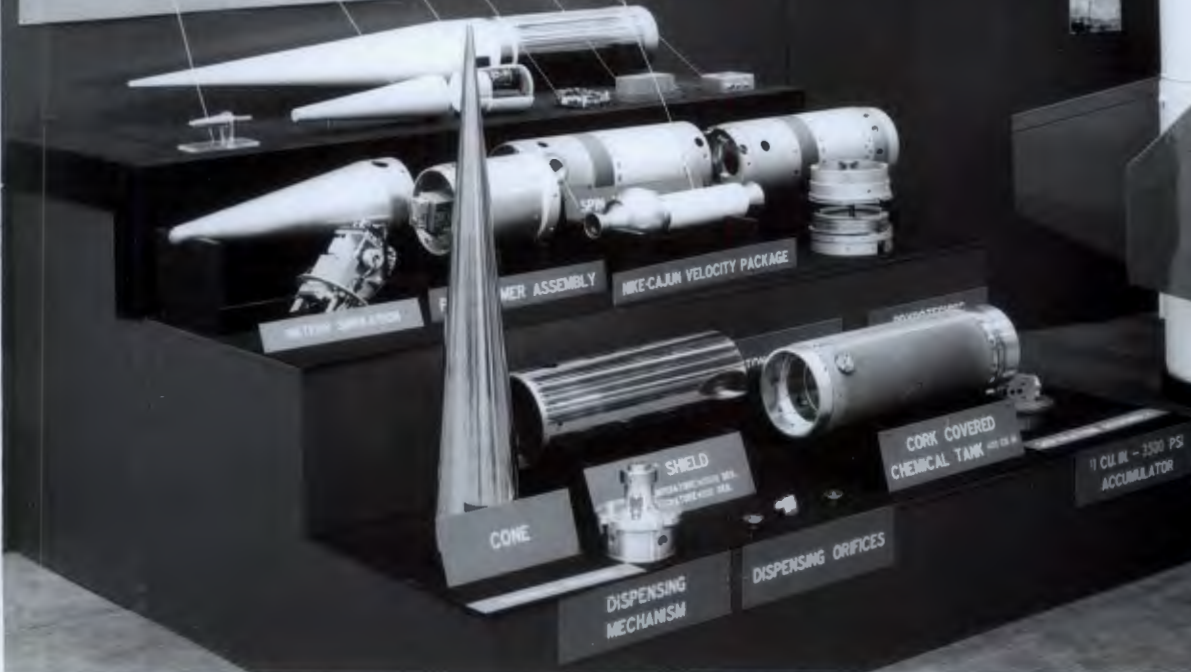
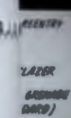
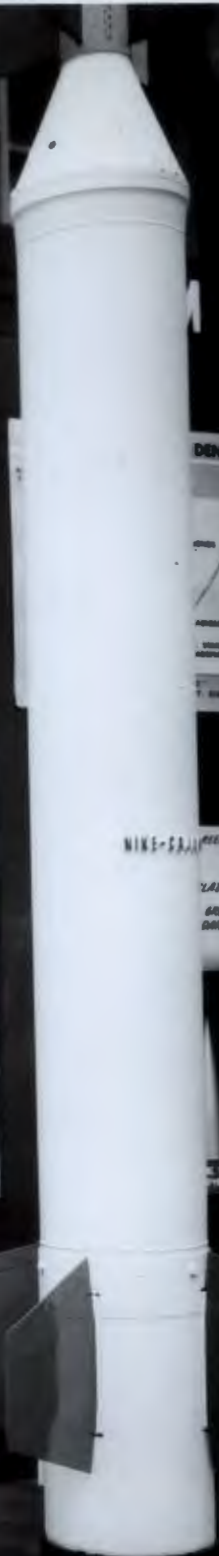
SHAPED-CHARGE ACCELERATOR



32,800 FPS
THE EXPLOSIVE COLLAPSES THE SPITBACK TUBE, REFORMS IT INTO A SOLID MASS, AND EXPELS IT THRU THE FRONT. THE LUCITE INHIBITOR COLLAPSES, SLOWING THE DEBRIS TO LESS THAN 5KM PER SECOND, THUS SEPARATING THE DEBRIS FROM THE DEENTRY PELLET.

WIND MEASUREMENT AT NIGHT
BY

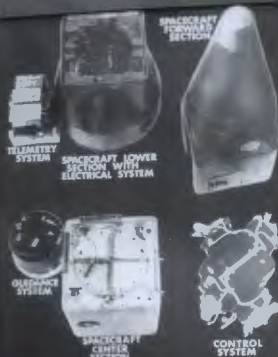
VEHICLE LIGHT SIGNAGE MUST BE PAID FOR BY THE
REGISTERED OWNER OF THE VEHICLE



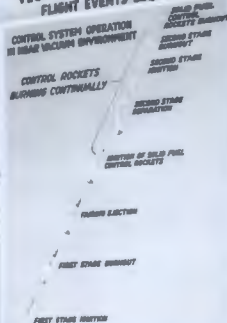
ROCKETRY VECTOR

FLIGHT RESEARCH OF ATTITUDE CONTROL SYSTEMS WITH SOLID FUEL ROCKETS

VECTOR SPACECRAFT COMPONENTS

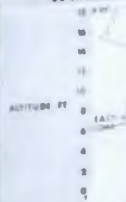


VECTOR RESEARCH VEHICLE FLIGHT EVENTS SEQUENCE



INFLATABLE 1-METER MYLAR
SPHERE ROBIN

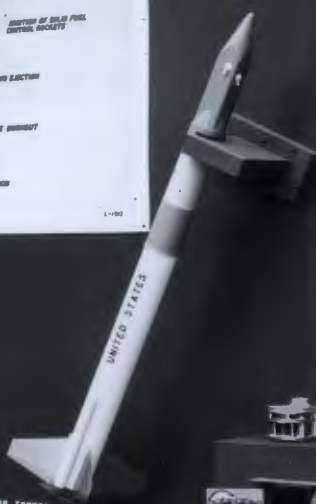
WIND MEASUREMENT



SMALL I

- PURPOSE:
RESEARCH
TEST PROCEDURE
- SPECIFIC APPLICATIONS:
1. RESEARCH
2. RESEARCH
3. RESEARCH
4. RESEARCH
1. RESEARCH
2. RESEARCH
3. RESEARCH
4. RESEARCH

YAW AND ROLL
SOLID FUEL
CONTROL ROCKETS

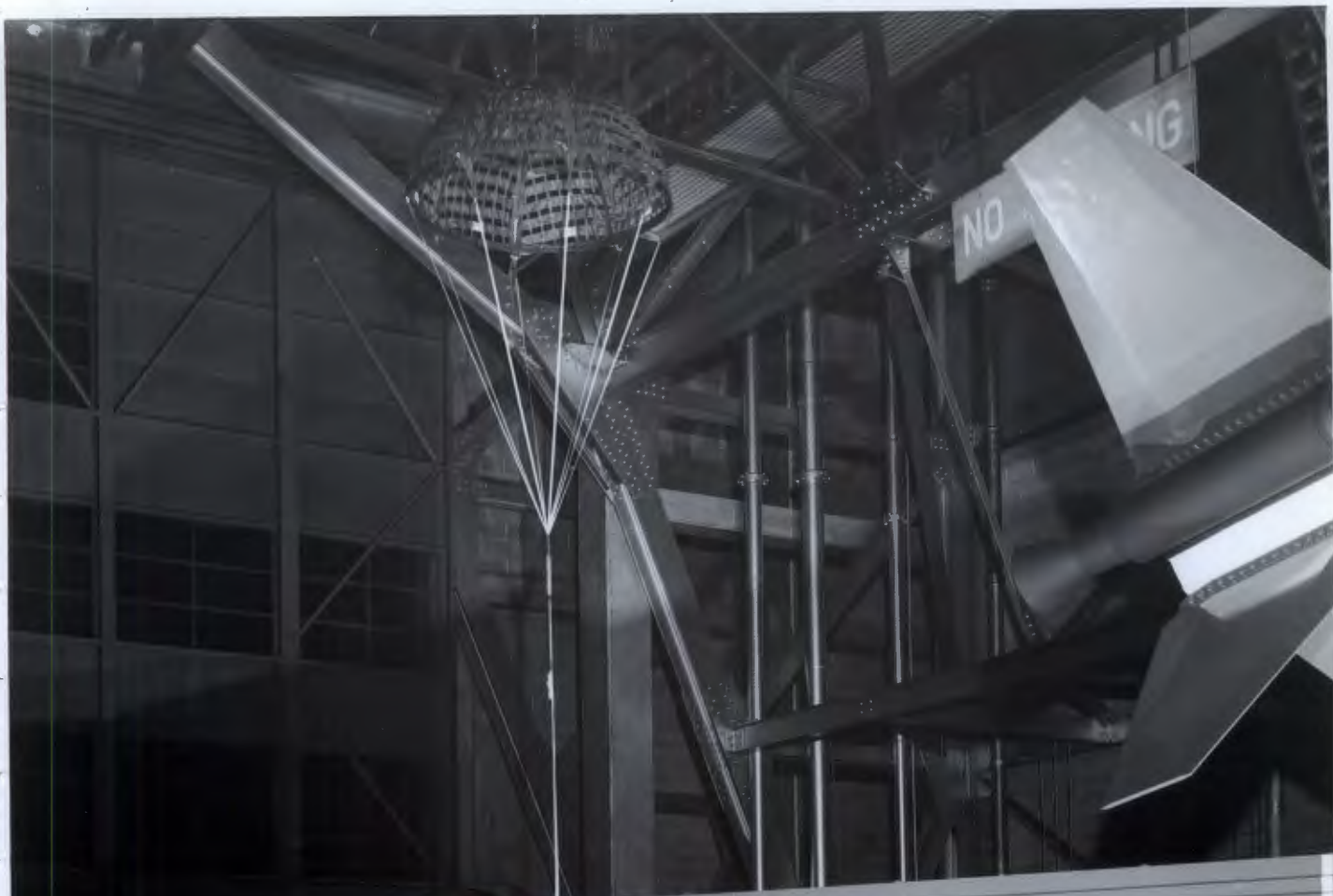


1/10 SCALE WITH TUBEL
MODEL

TEMPERATURE
MEASUREMENT PACK

USE CONE FOR TEMPERATURE
MEASUREMENT PACKAGE





ION

RECOVERY

TYPICAL MISSION



PHOTOGRAPHS

FINCH

MISSIONS



PHOTOGRAPHY DISTANCE 10000'

1000' HIGHER RESOLUTION

TYPICAL SYSTEM



LOCATION AIDS

RECOVERY IN RESEARCH

RECOVERY IN RESEARCH is a program of the NASA Langley Research Center, Hampton, Virginia. The program is designed to develop and test recovery systems for use in the future. The program is currently in the planning stage and will be completed by the end of 1964.

IN THE AIR



SEARCHLIGHT



SEARCHLIGHT

UNDER THE WATER



ON THE WATER

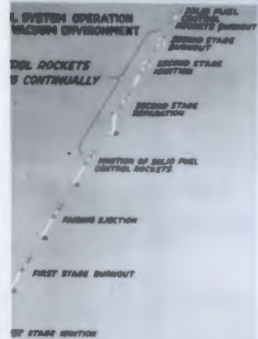


SEARCHLIGHT

SOLID FUEL ROCKETS

TYPICAL FLIGHT HARDWARE

RESEARCH VEHICLE FLIGHT EVENTS SEQUENCE



SCALE WIND TUNNEL
MODEL

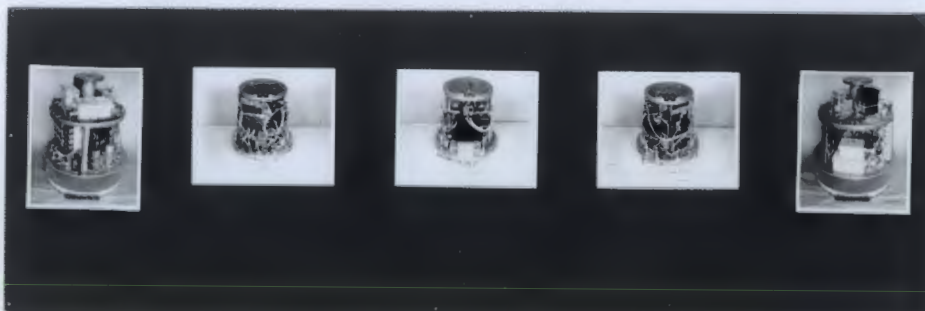


WALLOPS

PHOTOGRAPH



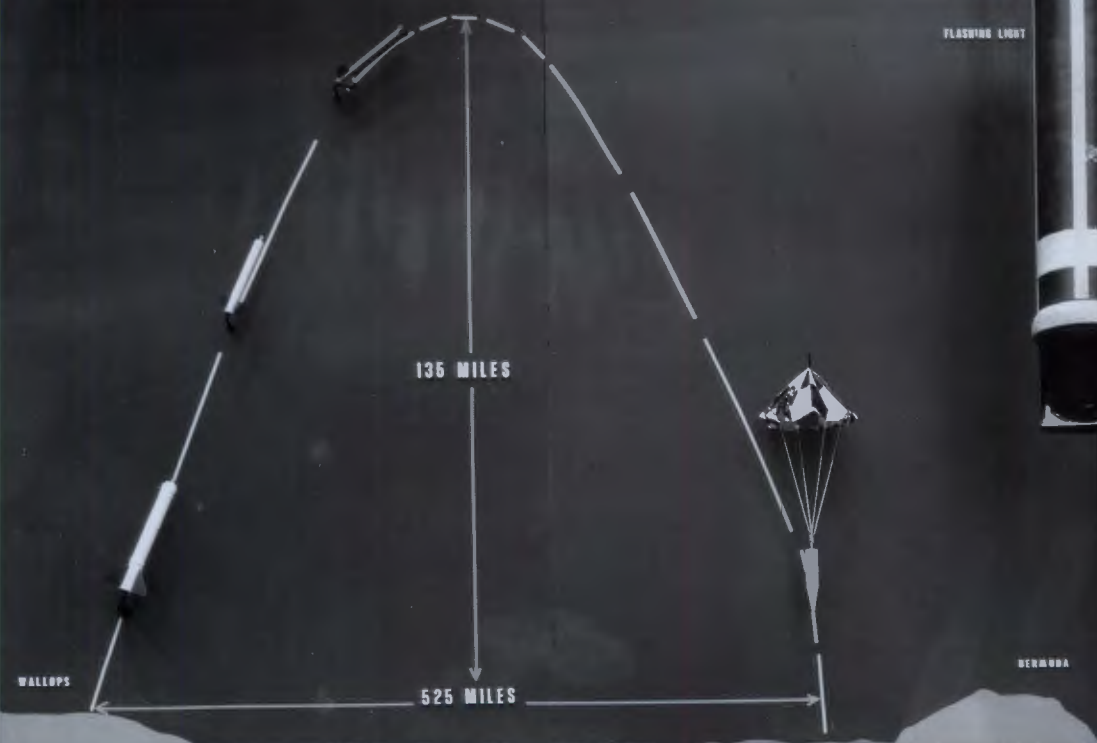
SPACECRAFT



RECOV

TYPICAL MISSION

TYPICAL SYSTEM



PARACHUTE

FLASHING LIGHT

ANTENNA

HYD MARKER

CAMERA P

PARACHUTE CONTAINER

PHOTOGRAPHS

FROM

MISSIONS

MATERIALS CONC



SPACECRAFT MATERIALS TESTING

DATA FILM RECOVERY

TEST MATERIALS

SYSTEM

LOCATION AIDS

RECOVERY IN RESEARCH

RECOVERY OF RESEARCH PAYLOADS IS PLAYING AN INCREASING ROLE IN INVESTIGATIONS OF SPACE-CRAFT MATERIAL BEHAVIOR. LABORATORY EXAMINATION OF MATERIAL SAMPLES WHICH HAVE WITHSTOOD A IDENTIFIED HEATING ENVIRONMENT, FOR EXAMPLE, ALLOW A MORE COMPLETE ANALYSIS OF MATERIAL BEHAVIOR AND MORE EFFICIENT DESIGN FOR FUTURE SPACECRAFT. OTHER RESEARCH PAYLOADS REQUIRING RECOVERY INCLUDE DATA CAPSULES CONTAINING TUBE RECORDERS OR CAMERAS AND VARIOUS BIOLOGICAL EXPERIMENTS RANGING FROM MAN TO URCHIN EGGS.

RECOVERY OF THESE PAYLOADS IS MORE THAN JUST THE SAFE LANDING OF A VEHICLE ON WATER OR LAND. IT INCLUDES, FOR EXAMPLE, FINDING THE PAYLOAD, HUMAN OR OTHERWISE, AFTER IT HAS LANDED. LOCATION AIDS - RADAR CHAFF, RADIO SIGNALS, DYE MARKERS - ARE A RAPIDLY EXPANDING PART OF RECOVERY TECHNOLOGY.

ANTENNA

SEE MARKER

AIRCRAFT RECEIVER SYSTEM

CAMERA POD

VISUAL DISPLAY

ANTENNA

UNDER THE WATER

3 MILES

PARACHUTE CONTAINER

MATERIALS NOT
CONE

TEST MATERIALS



Payload recovery by sonar detection



TRANSMITTERS
INTERNAL AND
EXTERNAL PAYLOAD
MOUNTING

RECEIVER
LOW SPEED MOTOR
SEARCH & DIVER USE

IN THE AIR



RADAR CHAFF
100 MILES



RADAR REFLECTIVE PARACHUTE
50 MILES

ON THE WATER

DYE MARKER

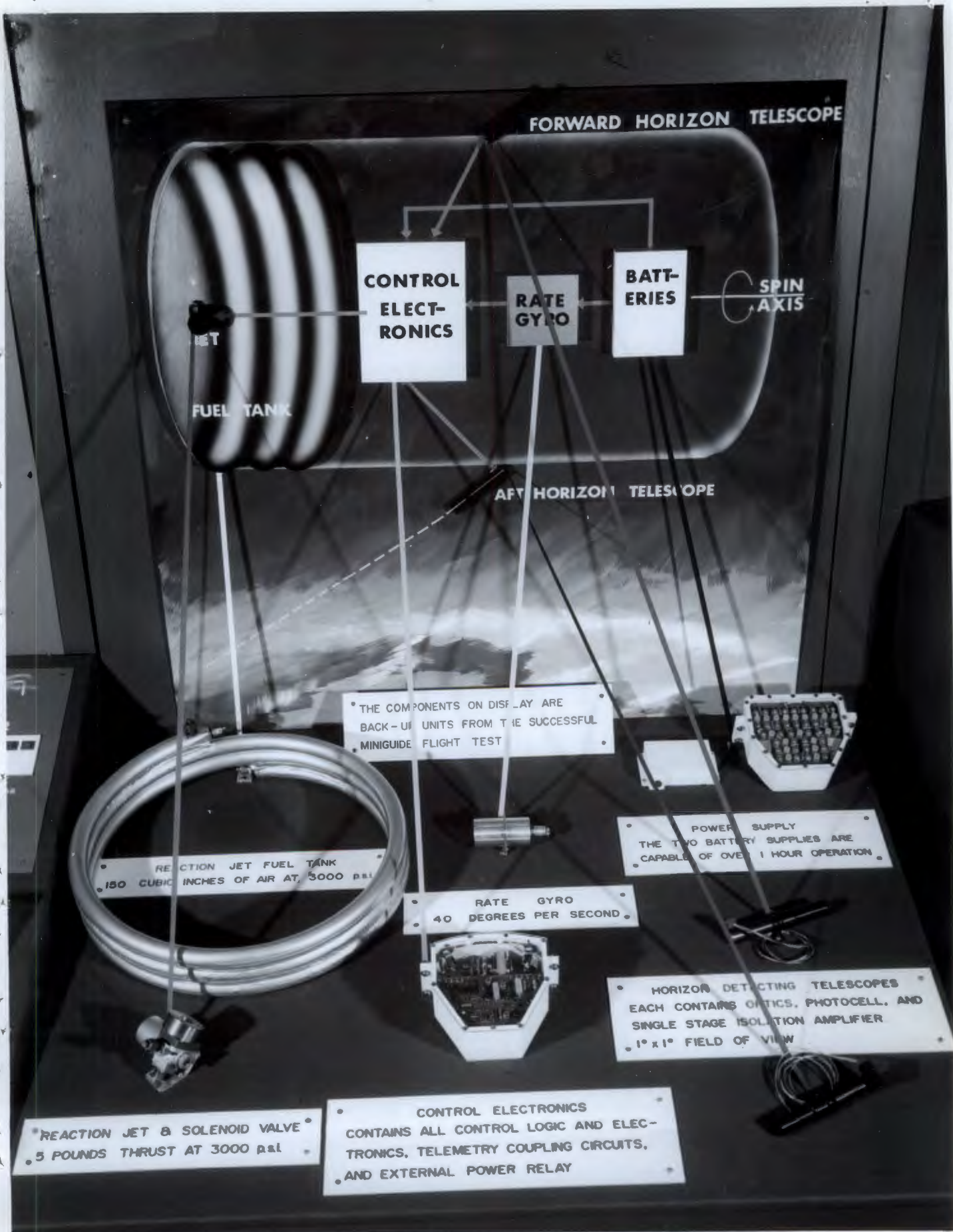
3 MILES

FLASHING LIGHT
3 MILES

RADIO TRANSMISSION TO AIRCRAFT
20 TO 70 MILES

BEACON SIGNAL FROM NOSE CONE
IS RECOVERED BY THE AIRCRAFT
ANTENNA AT UPPER LEFT AND THEN
DISPLAYED ON THE DISCLOSED

FILMS-
TRAILING
RECOVER



HORIZON.

SCANNER EXPERIMENT

VERTICALLY
CONTROLLED AND
SPIN STABILIZED
SPACECRAFT (S/C)
3/4 R.P.S.

STARMAPPER
SPACECRAFT POINTING
ANGLE OBTAINED
FROM STAR MAP TO
.015° ACCURACY

RADIOMETER
RADIANCE MEASUREMENTS

.02° VERTICAL
FIELD OF VIEW
(DEFINITION
OF 1 TO 2 KM)

FIELD OF VIEW
IS SCANNED OVER
15° ANGLE

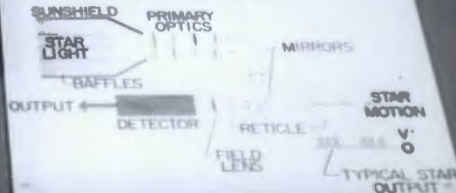
REAL TIME GROUND TRACKING
AND DATA RECEPTION



D-61 RADIOMETER
SCANNED BY VEHICLE



STARMAPPER



X-15 RADIOMETER



GUIDANCE AND CONTROL

SCANNER

HORIZON DEFINITION RESEARCH

PURPOSE: TO DETERMINE THE APPEARANCE AND LOCATION OF THE EARTH'S HORIZON WHEN VIEWED FROM SPACE. THIS INFORMATION IS REQUIRED IN THE DEVELOPMENT OF HIGH-ACCURACY GUIDANCE SENSORS REQUIRED FOR FUTURE SPACE MISSIONS.

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SCANNER EXPERIMENT

VERTICALLY CONTROLLED AND SPIN STABILIZED SPACECRAFT (S/C) 3/4 S.P.S.

STARMAPPER SPACECRAFT POINTING ANGLE OBTAINED FROM STAR MAP TO .015° ACCURACY

RADIOMETER RADIANCE MEASUREMENTS

.02° VERTICAL FIELD OF VIEW (DEFINITION OF 1 TO 2 KM)

FIELD OF VIEW IS SCANNED OVER 75° ANGLE

REAL TIME GROUND TRACKING DATA RECEPTION

FLUID LOGIC

FLUID STATE DEVICES

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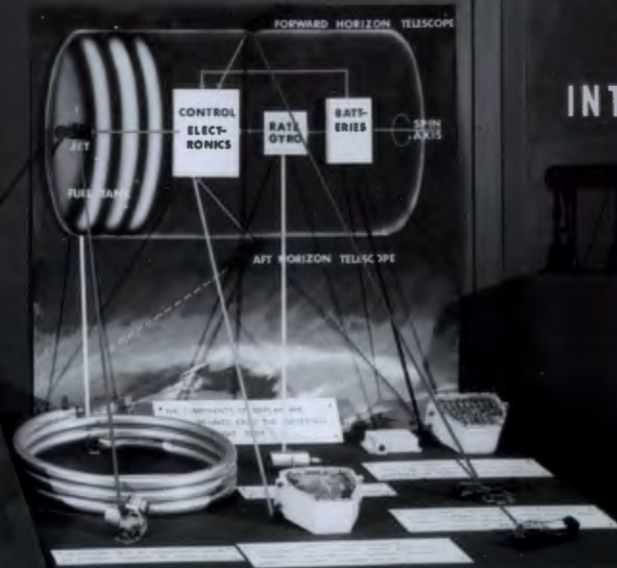
VORTEX RATE SENSOR



MINIGUIDE

MINIGUIDE ATTITUDE CONTROL FOR SPIN STABILIZED VEHICLES

HORIZON DETECTING TELESCOPES RIGIDLY ATTACHED TO THE VEHICLE PROVIDE ATTITUDE ERROR SIGNALS, AND A RATE GYRO PROVIDES A STABILIZING SIGNAL. THESE SIGNALS ARE COMBINED AND USED TO OPERATE A CONTROL JET. THE VEHICLE SPIN IS USED TO SCAN THE TELESCOPES AND THE CONTROL JET SO THAT A SINGLE CONTROL CHANNEL CAN PROVIDE CONTROL IN TWO DIRECTIONS



N

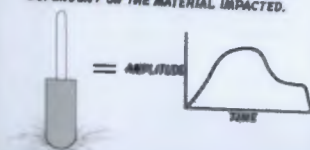
S

PENETROMETER

UNDER STUDY
WHAT IS THE LUNAR SURFACE?
ROCK? DUST? SOMETHING ELSE?

TO FIND THE ANSWER...

... LRC HAS LEARNED THAT IMPACT CONDITIONS, SUCH AS AMPLITUDE AND TIME, ARE DEPENDENT ON THE MATERIAL IMPACTED.



TO MAKE THESE MEASUREMENTS A PENETROMETER IS USED

A PENETROMETER IS AN INSTRUMENT CONTAINING:

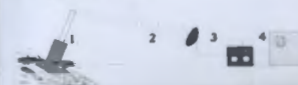
- AN ANTENNA
- BATTERIES
- A RADIO TRANSMITTER
- A DEVICE TO CONVERT DECELERATION TO VOLTAGE.

SOME RESULTS USING EARTH MATERIALS ARE...



UPON IMPACT THE PENETROMETER...

1. MEASURES DECELERATION AND...
2. RADIOS THIS INFORMATION TO A DISTANT...
3. RECEIVER MOUNTED IN A SPACECRAFT.
- THIS MEASUREMENT MAY BE DISPLAYED ON...
4. AN OSCILLOSCOPE



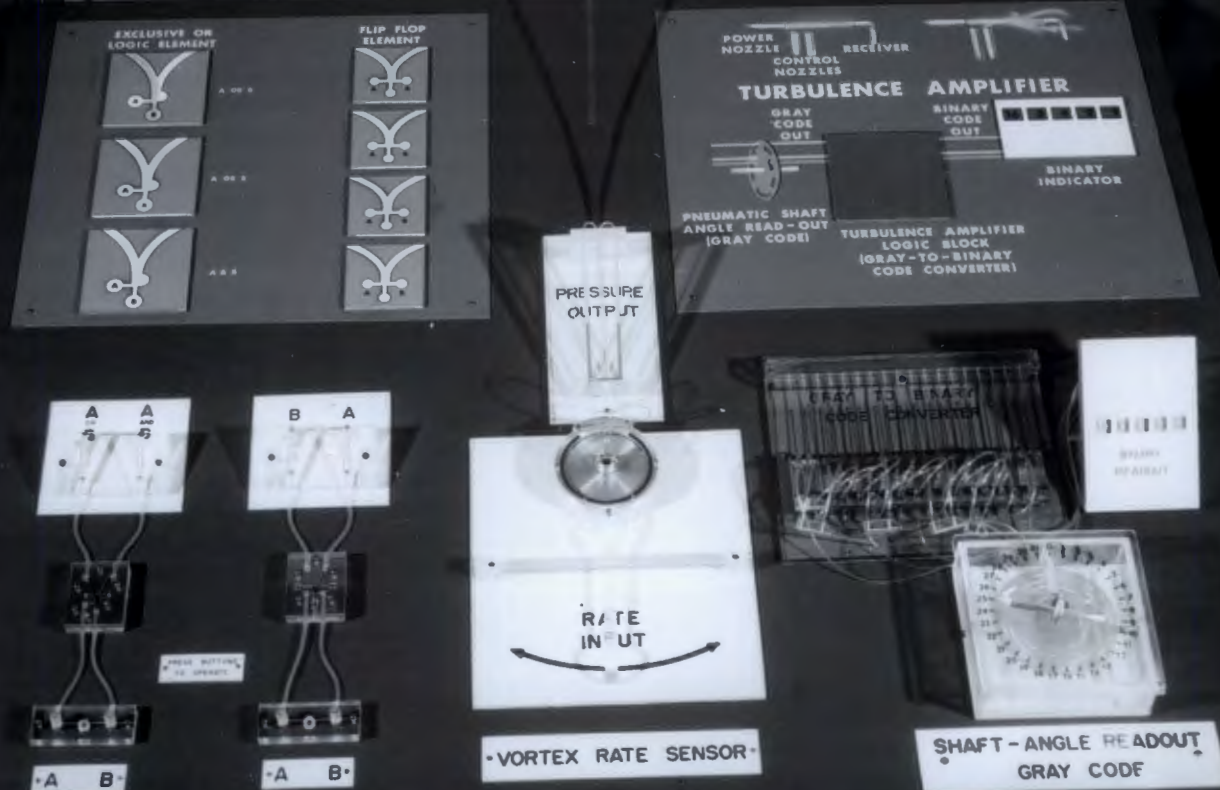
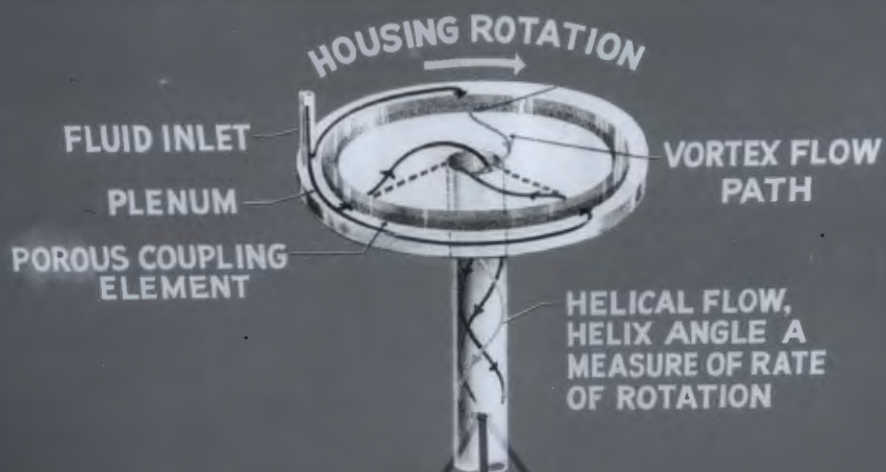
VOLCANIC ROCK

CLAY

SAND



VORTEX RATE SENSOR







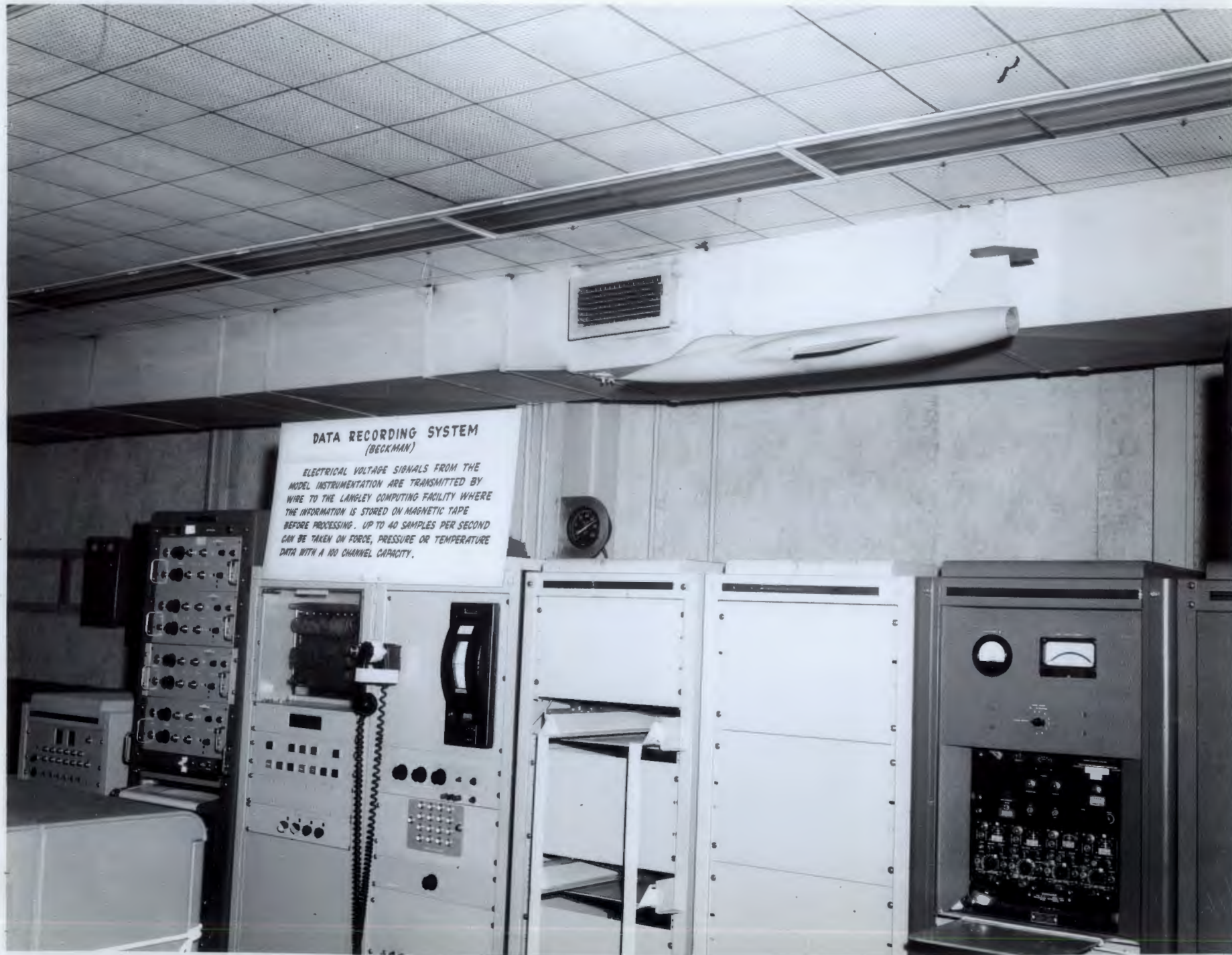


**TUNNEL FAN SPEED
CONTROL STATION**
THE WIND TUNNEL TEST SECTION
SPEED CAN BE VARIED FROM MACH
NUMBER 0.2 TO 1.1 BY VARYING THE RPM
OF THE FAN MOTORS. SHADOWGRAPH
PICTURES OF THE MODEL AND MANO-
METER BOARD PHOTOS ARE MADE HERE

COMPRESSOR CONTROL STATION
THE 36,000 HP AIR REMOVAL COMPRESSOR IS
OPERATED FROM THIS STATION TO SET THE TUNNEL
SPEED FROM MACH NUMBERS OF 0.2 TO 1.30. IN
ADDITION TO USING THE MAIN TUNNEL FAN DRIVE
SYSTEM, THE AMOUNT OF BOUNDARY AIR REMOVAL IS
CONTROLLED BY VARYING THE COMPRESSOR RPM AND
THROTTLING THE AIRFLOW REMOVAL FROM THE TEST
SECTION PLENUM CHAMBER WITH A 10 FOOT VALVE

**DATA RECORDING SYSTEM
(BECKMAN)**

ELECTRICAL VOLTAGE SIGNALS FROM THE
MODEL INSTRUMENTATION ARE TRANSMITTED BY
WIRE TO THE LANGLEY COMPUTING FACILITY WHERE
THE INFORMATION IS STORED ON MAGNETIC TAPE
BEFORE PROCESSING. UP TO 40 SAMPLES PER SECOND
CAN BE TAKEN ON FORCE, PRESSURE OR TEMPERATURE
DATA WITH A 100 CHANNEL CAPACITY.



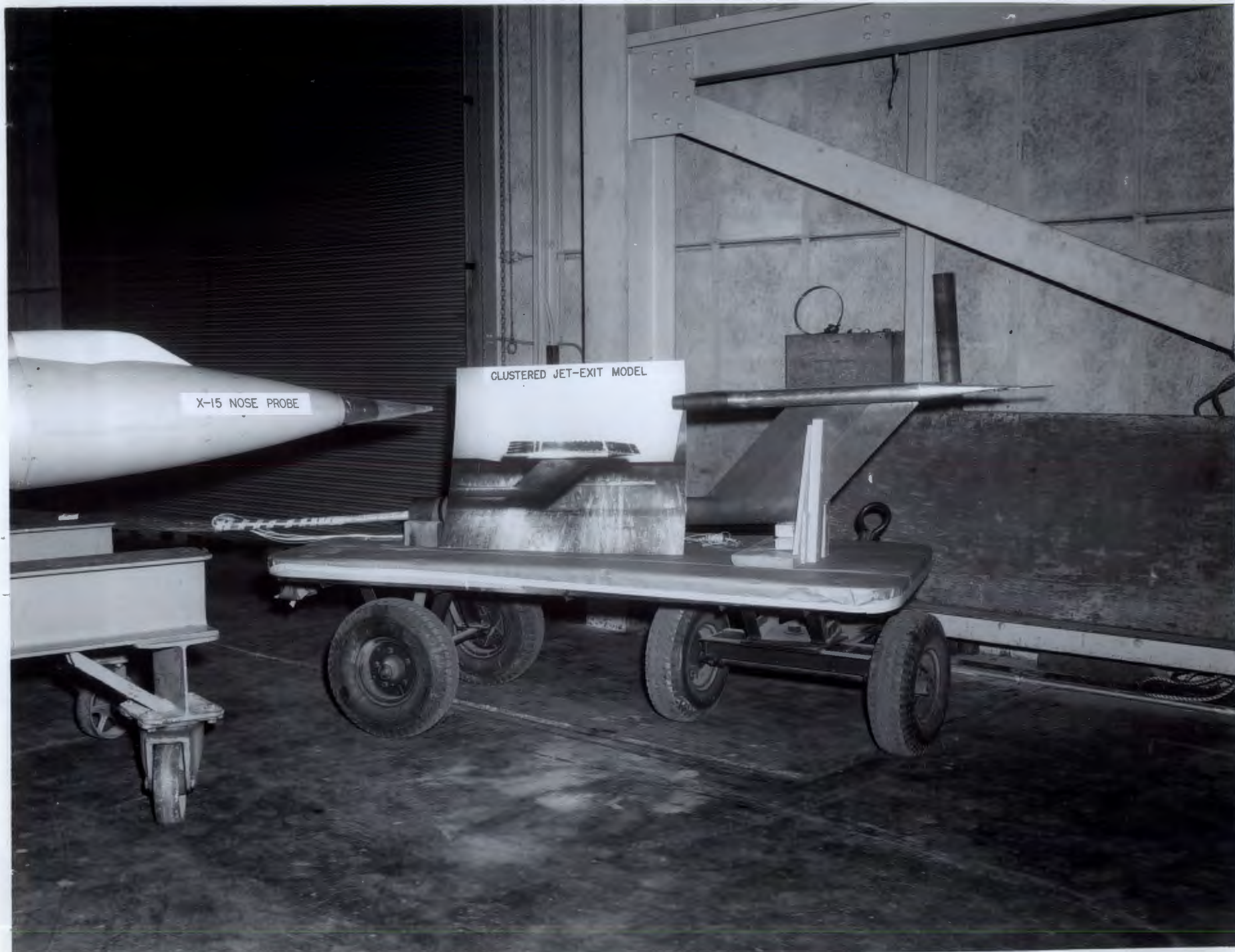
DRIVE FANS

TWO STAGE-AXIAL FLOW - COUNTER ROTATING

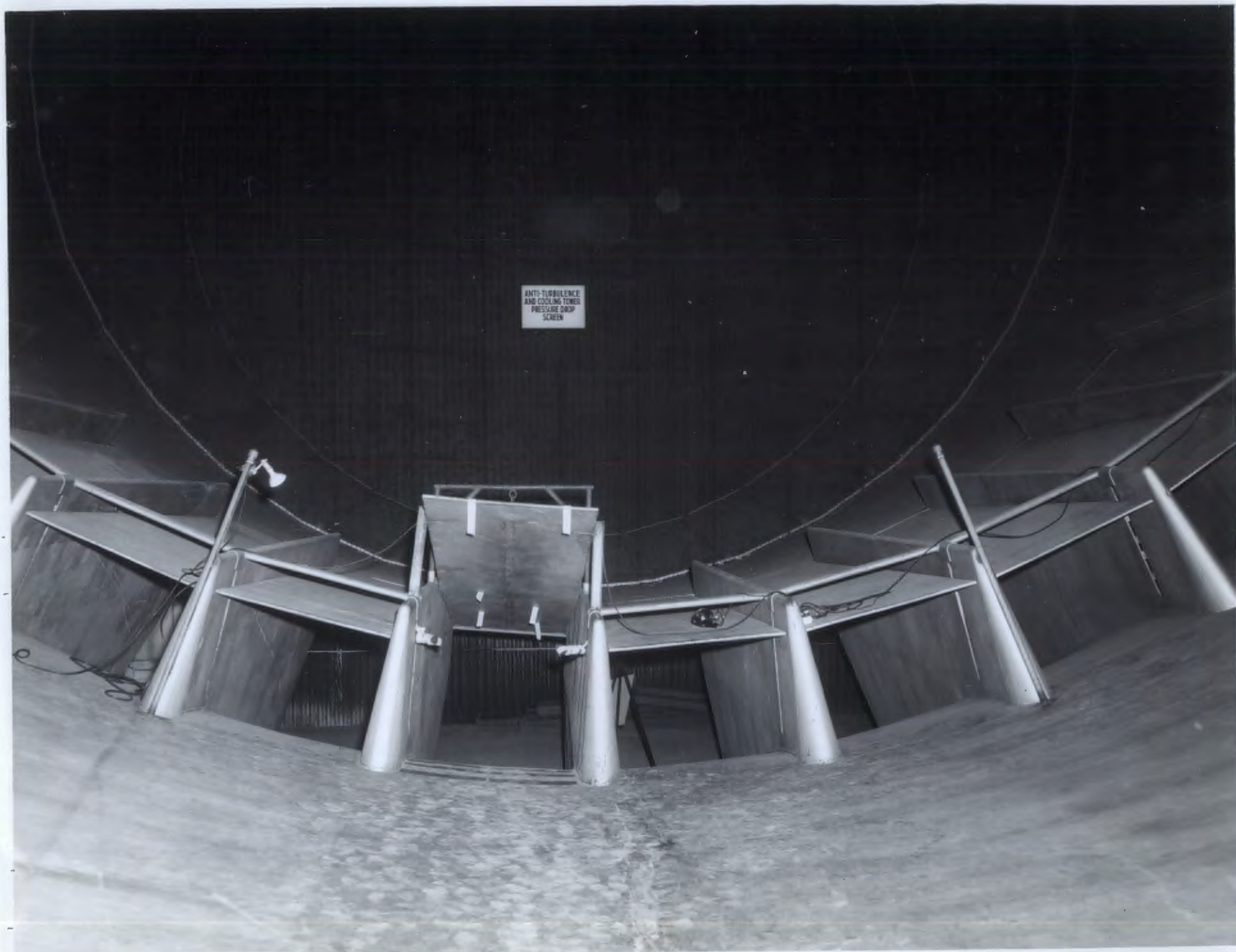
FAN DIAMETER	34 FEET
NACELLE DIAMETER	20 FEET
FIRST STAGE FAN	25 BLADES
SECOND STAGE FAN	26 BLADES
ROTATIONAL SPEED (MAX.)	372 RPM
TOTAL POWER (MAX.)	65,000 HP
TOTAL THRUST (MAX.)	126,000 LB
EFFICIENCY	95%

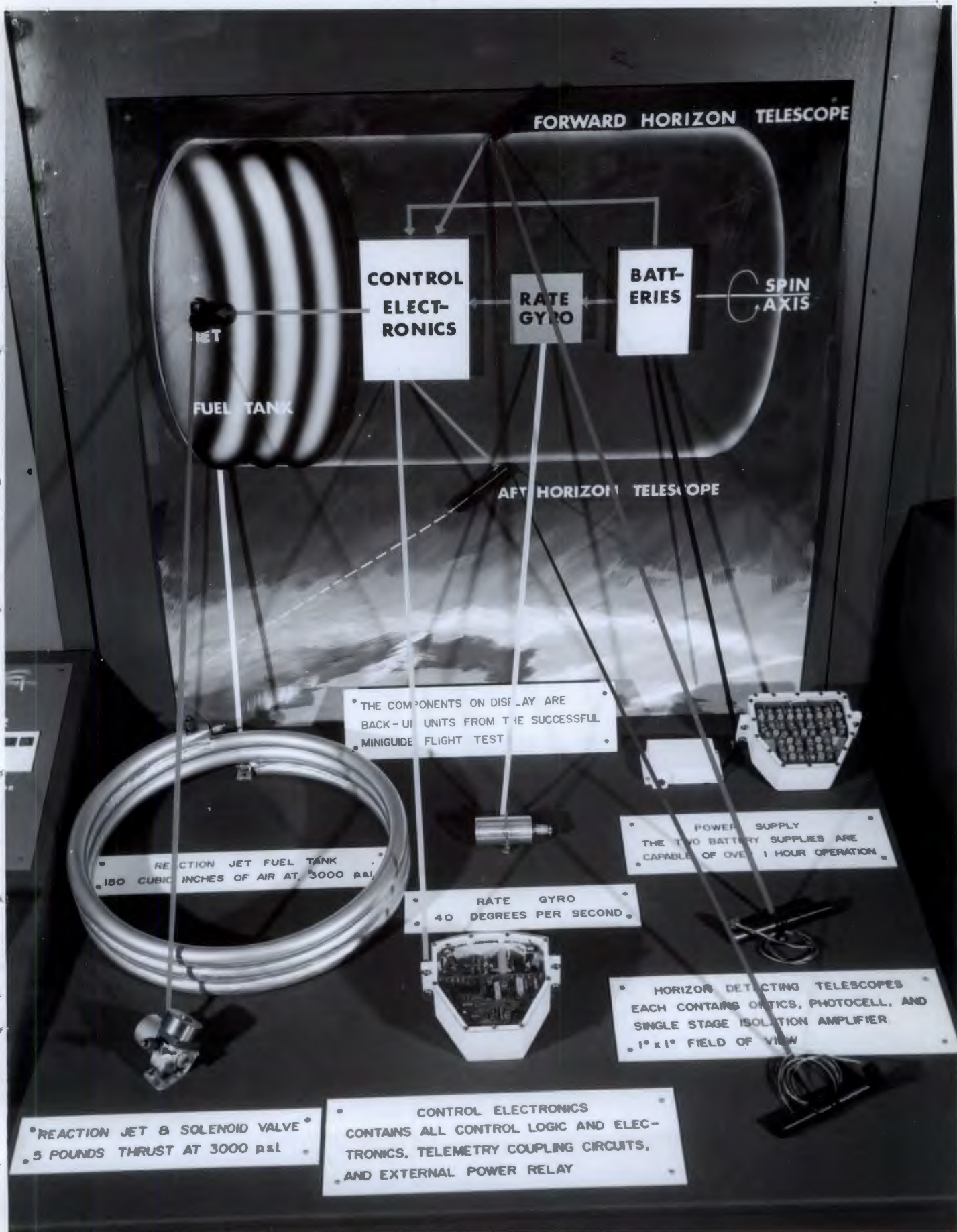
TEST SECTION AIR SPEED CONTROLLED BY DRIVE FAN SPEED
FAN BLADES MADE OF LAMINATED SPRUCE IN (NASA) NASA SHOPS

DRIVE SECTION STEELWORK BY: A. N. S. D. CO.



NASA
L-84-5310





GUIDANCE AND CONTROL

SCANNER

HORIZON DEFINITION RESEARCH

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STARMAPPER SPACECRAFT POINTING ANGLE OBTAINED FROM STAR MAP TO .015° ACCURACY

RADIOMETER RADIANCE MEASUREMENTS
.02° VERTICAL FIELD OF VIEW (DEFINITION OF 1 TO 2 KM)

FIELD OF VIEW IS SCANNED OVER 13° ANGLE

REAL TIME GROUND TRACKING DATA RECEPTION

D-61 RADIOMETER

STARMAPPER

FLUID LOGIC

FLUID STATE DEVICES

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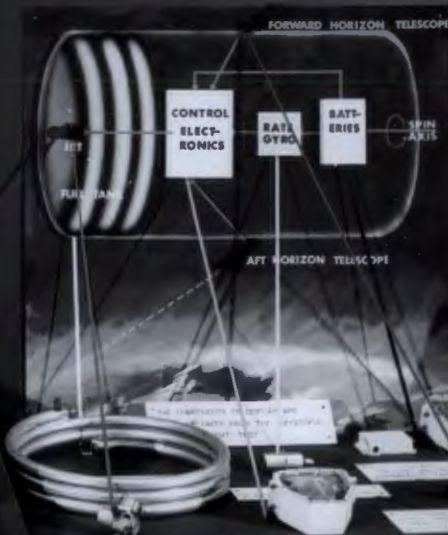
VORTEX RATE SENSOR

HOUSING ROTATION
FLUID INLET
PLENUM
POROUS COUPLING ELEMENT
VORTEX FLOW PATH
HELICAL FLOW, HELIX ANGLE A MEASURE OF RATE OF ROTATION

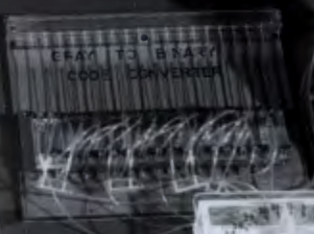
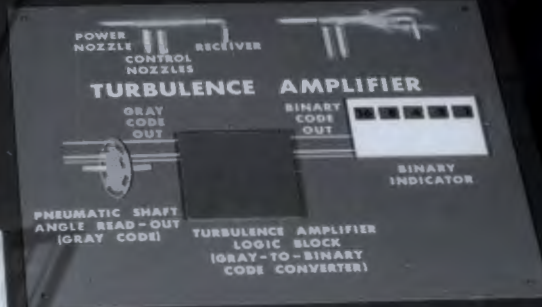
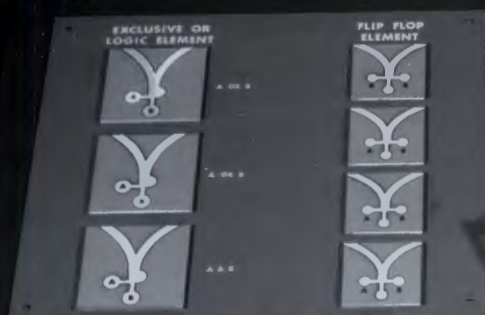
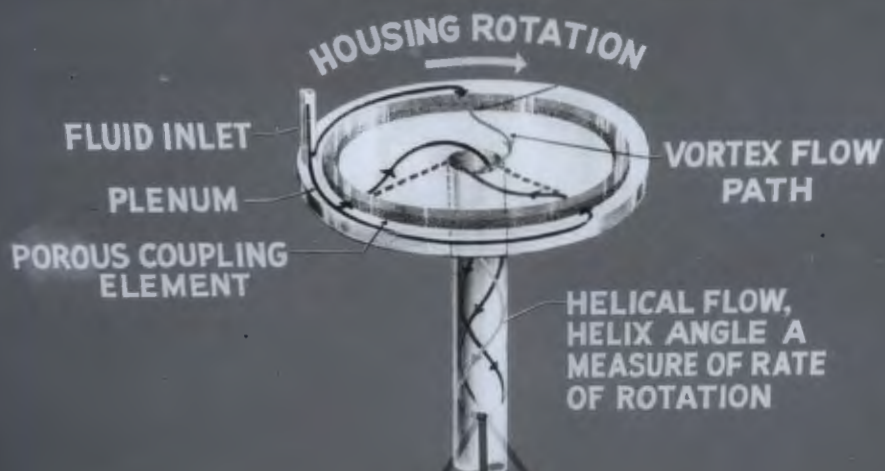
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VORTEX RATE SENSOR

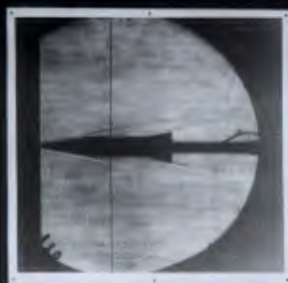


VORTEX RATE SENSOR

SHAFT-ANGLE READOUT
GRAY CODE



JET PLUMING



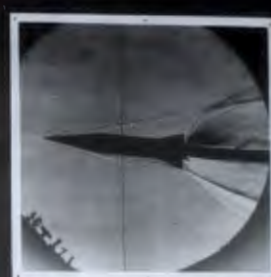
NO JET PLUME
FLOW ATTACHED TO FLARE
STABLE AT ALL ANGLES



SIMULATED ALTITUDE 180,000 FT.
STATIC PRESSURE RATIO
(P/P_∞)=100
FLOW ATTACHED TO FLARE
STABLE AT ALL ANGLES



SIMULATED ALTITUDE 215,000 FT.
STATIC PRESSURE RATIO 1200
FLOW SEPARATION OVER FLARE
UNSTABLE AT SMALL ANGLES

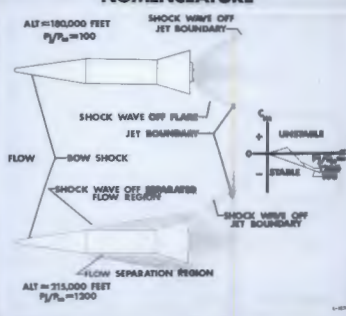


SIMULATED ALTITUDE 215,000 FT.
STATIC PRESSURE RATIO 1200
FLOW ATTACHED TO WINDWARD
SIDE OF FLARE STABLE AT
APPROXIMATELY 5° AND LARGER
ANGLES

2. HYPERSONIC FLOW FIELD WITH AND WITHOUT ROCKET JET PLUME

AERODYNAMIC VEHICLE STABILITY PROBLEM

FLOW FIELD AND VEHICLE STABILITY NOMENCLATURE



WIND TUNNEL MODELS

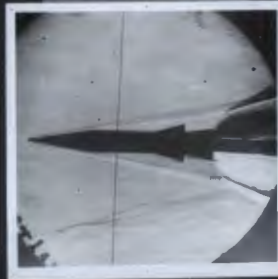


3. DEVICES STUDIED TO REDUCE VEHICLE INSTABILITY

DEVICE: BICOMICAL FLARE
RESULT: NEGATIVE



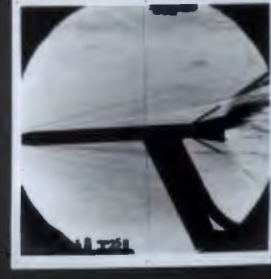
DEVICE: ROCKET NOZZLE EXIT
DISPLACED DOWNSTREAM
RESULT: NEGATIVE



DEVICE: BOUNDARY LAYER
VORTEX GENERATOR
RESULT: NEGATIVE

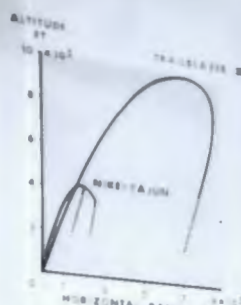


DEVICE: EXTENDABLE FLAPS
RESULT: POSITIVE



RESEARCH IN

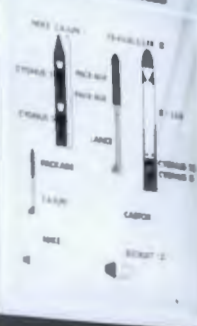
VEHICLE TRAJECTORIES



PHYSICAL THEORY OF METEORS

- UNKNOWN:**
1. INITIAL MASS
 2. DENSITY
 3. SHAPE
 4. DRAG COEFFICIENT
 5. HEAT TRANSFER/ABLATION PROCESSES
- OBSERVATIONAL DATA:**
1. VELOCITY
 2. DECELERATION
 3. INTENSITY
 4. RADIO ECHO
 5. SPECTRA
- CRITICAL CONSTANTS:**
1. LUMINOUS EFFICIENCIES
 2. IONIZATION EFFICIENCIES

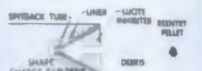
METEOR VEHICLES



NIKE CAJUN ARCAS HASP DART

METEOR PH 2003

SHAPED-CHARGE ACCELERATOR

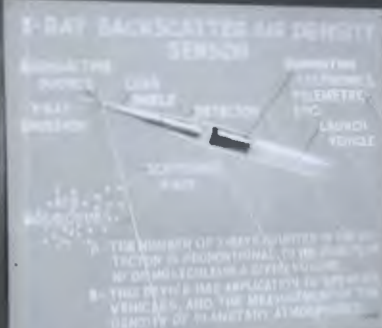


THE EXPLOSIVE COLLAPSES THE SPITBACK TUBE, REFORMS IT INTO A SOLID MASS, AND EXPELS IT THRU THE FRONT. THE LINER INHIBITOR COLLAPSES, SLOWING THE DEBRIS TO LESS THAN 5 KM PER SECOND, THUS SEPARATING THE DEBRIS FROM THE REENTRY PELLET.

WIND MEASUREMENT AT NIGHT BY CHEMICAL RELEASE



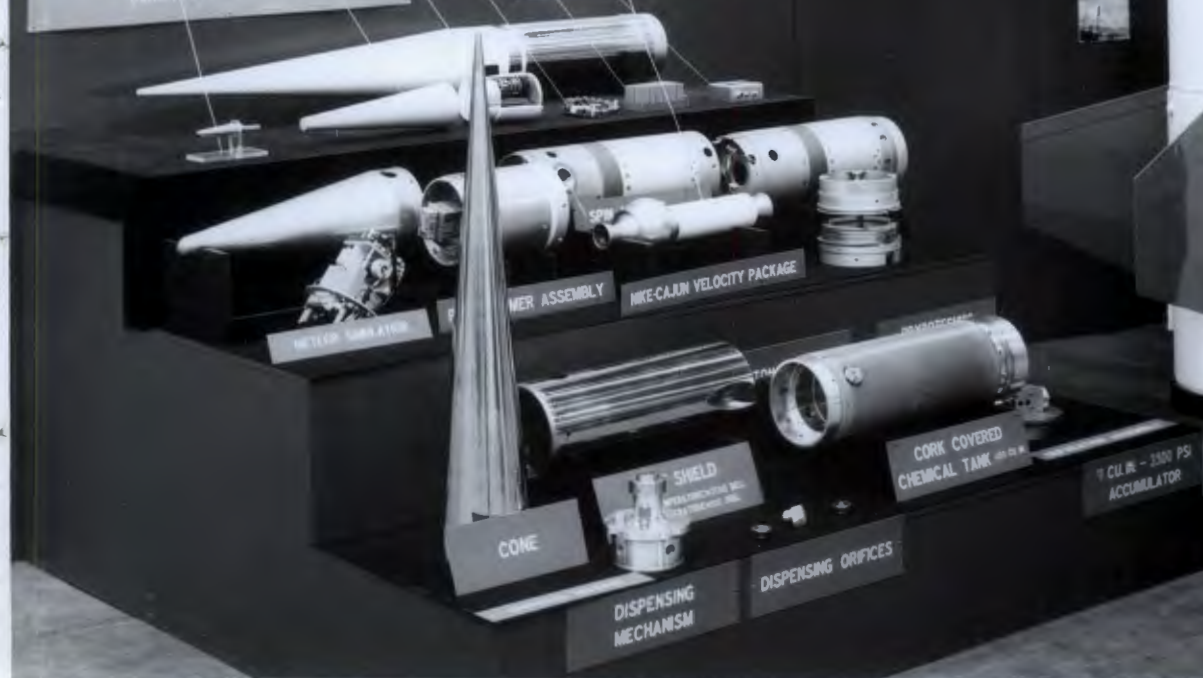
VISIBLE LIGHT CAMERA DETECTS PUFFS OF CHEMICAL RELEASE OF THE 6 FOOT RAYTRAC



THE NUMBER OF X-RAY COUNTS IN THE DETECTOR IS PROPORTIONAL TO THE SQUARE OF THE DENSITY OF THE AIR. THIS PRINCIPLE HAS APPLICATIONS TO SPACE VEHICLES, AND THE MEASUREMENT OF THE DENSITY OF PLANETARY ATMOSPHERES.

NIKE-CAJUN

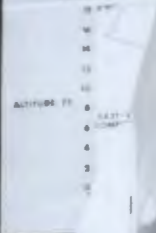
LAZOR (LASER DART)



LOGY VECTOR

INFLATABLE FIFTY-FOOT MYLAR
SPHERE ROBIN

WIND MEASUREMENT

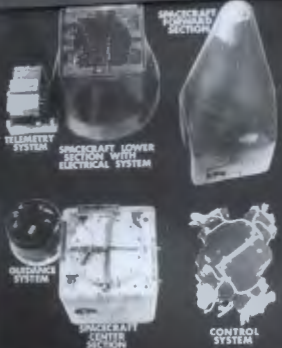


SMALL I

- PURPOSE:**
RESEARCH
- SPECIFIC APPLICATIONS:**
1. PARACHUTE - T
2. FALLING SPHERE
3. CHAFF (1000)
4. PARACHUTE (1000)
5. FALLING MYLAR SPHERE
6. PARACHUTE - TELEMETRY

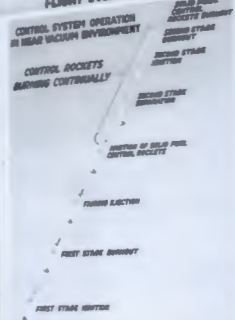
YAW AND ROLL
SOLID FUEL
CONTROL ROCKETS

VECTOR SPACECRAFT COMPONENTS



FLIGHT RESEARCH OF ATTITUDE CONTROL SYSTEMS WITH SOLID FUEL ROCKETS

VECTOR RESEARCH VEHICLE FLIGHT EVENTS SEQUENCE



1/10 SCALE WIND TUNNEL MODEL

TEMPERATURE MEASUREMENT PACKAGE

ICE CONE FOR TEMPERATURE MEASUREMENT PACKAGE





ION

RECOVERY

TYPICAL MISSION



TYPICAL SYSTEM



LOCATION AIDS

RECOVERY IN RESEARCH

RECOVERY IN RESEARCH is a program of the NASA Langley Research Center, Hampton, Virginia. It is designed to provide a means of recovering research vehicles and equipment in the event of an emergency landing or crash. The program includes the development of recovery systems, the testing of recovery equipment, and the recovery of research vehicles and equipment.

IN THE AIR



REAR VIEW

REAR VIEW

ON THE WATER



REAR VIEW

REAR VIEW

REAR VIEW

REAR VIEW

PHOTOGRAPHS

VIDEO

MISSIONS



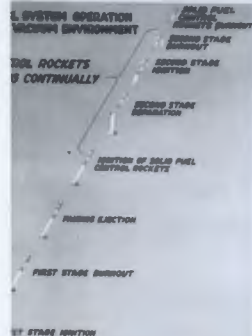
PHOTOGRAPHY BY NASA

PHOTOGRAPHY BY NASA

SOLID FUEL ROCKETS

TYPICAL FLIGHT HARDWARE

RESEARCH VEHICLE FLIGHT EVENTS SEQUENCE

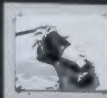


SCALE WIND TUNNEL
MODEL



Wallops

PHOTOGRAPH



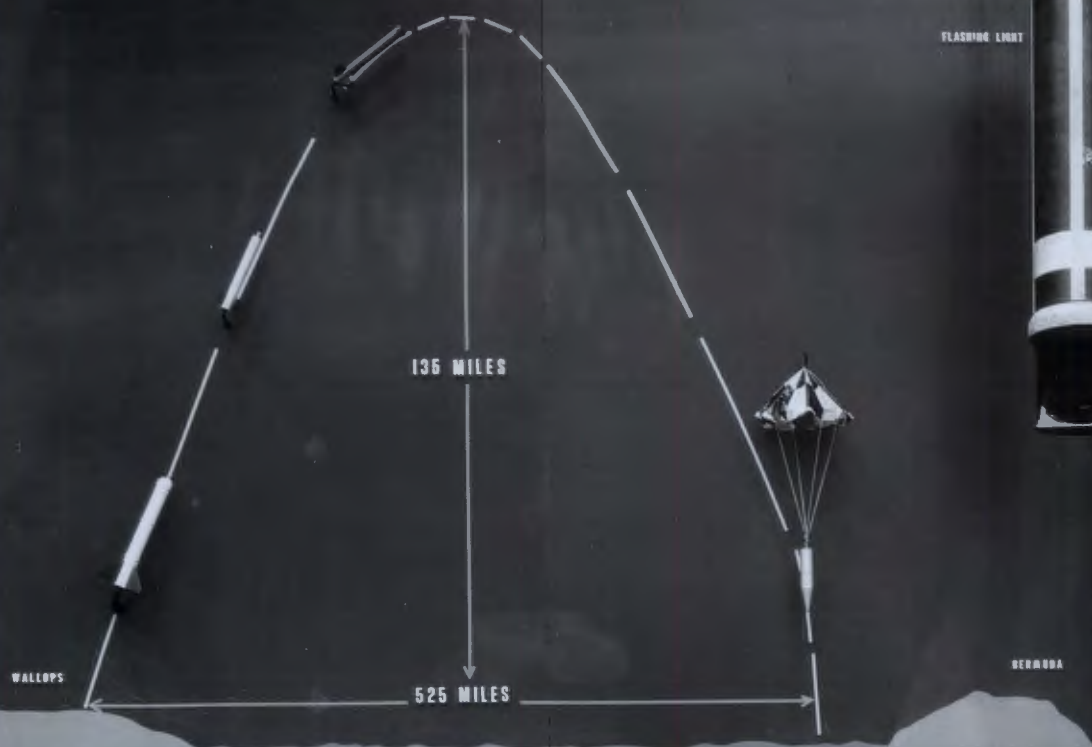
SPACECRAFT



RECOVER

TYPICAL MISSION

TYPICAL SYSTEM



PARACHUTE

FLASHING LIGHT

ANTENNA

BYE MARKER

CAMERA P

PARACHUTE CONTAINER

RECOVERY

PHOTOGRAPHS

FROM

MISSIONS

MATERIALS CONTAINER



SPACECRAFT MATERIALS TESTING

DATA FILM RECOVERY

TEST MATERIALS

LOCATION AIDS

IN THE AIR

UNDER THE WATER

ON THE WATER

BYE MARKER
3 MILES

FLASHING LIGHT
3 MILES

WASH TRANSITING TO AIRCRAFT 30 TO 70 MILES

SEARCH SIGNAL FROM CODE JUNE
IS RECEIVED BY THE AIRCRAFT
ANTENNA AT UPPER LEFT AND THE
DISPLAYED ON THE OSCILLOSCOPE.

TRANSMITTERS

RECEIVER
LOW SPEED BOAT
SEARCH & REVER USE

HORIZON.

SCANNER EXPERIMENT

VERTICALLY
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3/4 R.P.S.

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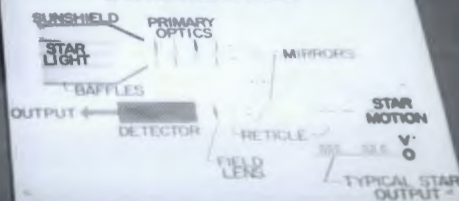
REAL TIME GROUND TRACKING
AND DATA RECEPTION



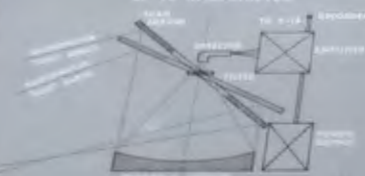
D-61 RADIOMETER
SCANNED BY VEHICLE



STARMAPPER



X-12 RADIOMETER



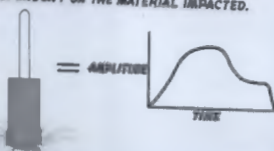
N S

PENETROMETER

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ROCK? DUST? SOMETHING ELSE?

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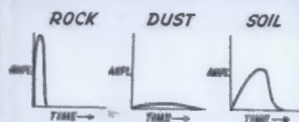


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3. RECEIVER MOUNTED IN A SPACECRAFT.
- THIS MEASUREMENT MAY BE DISPLAYED ON...
4. AN OSCILLOSCOPE



VOLCANIC ROCK

CLAY

SAND





NASA
L-64-5355



**TUNNEL FAN SPEED
CONTROL STATION**
THE WIND TUNNEL TEST SECTION
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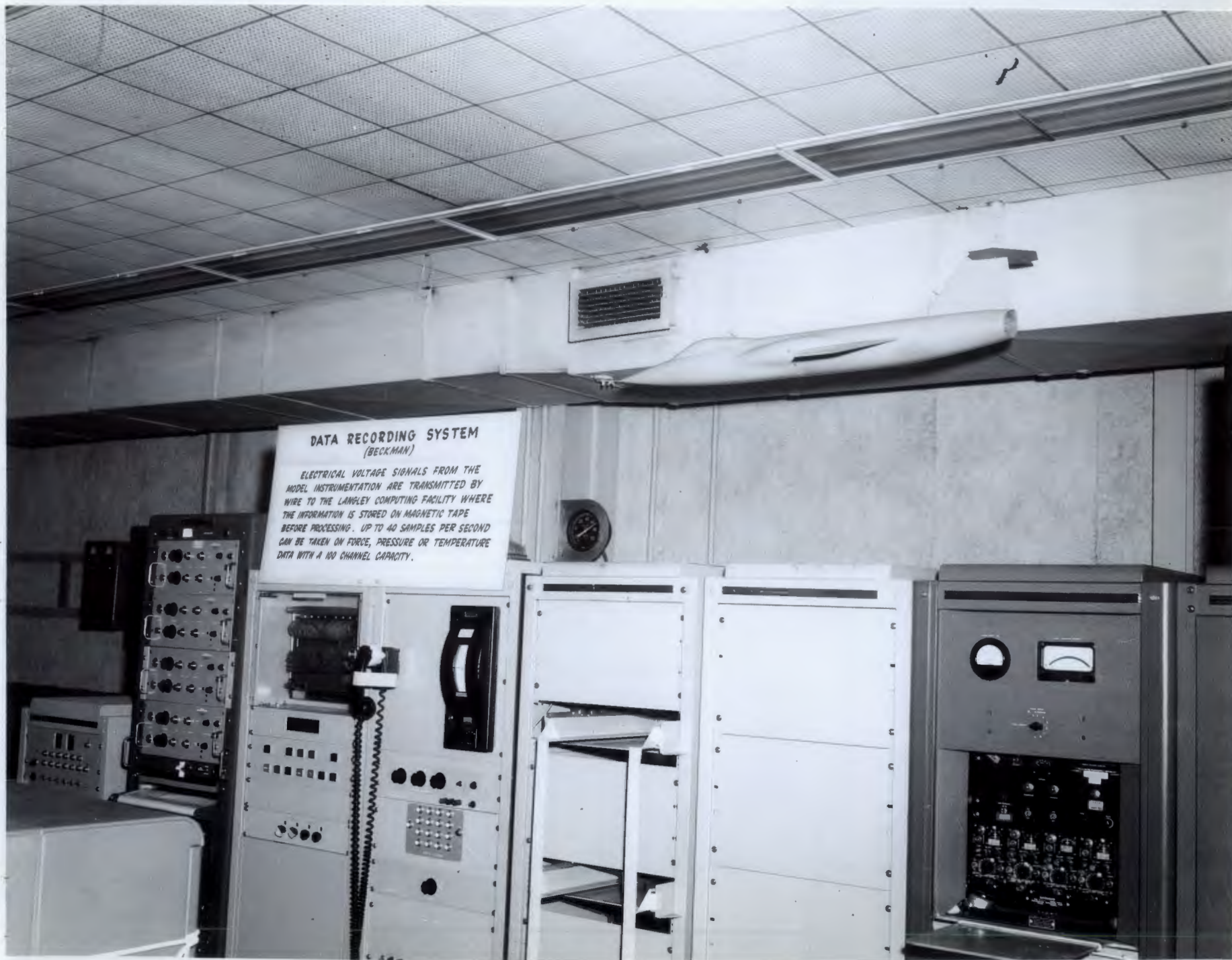
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MODEL INSTRUMENTATION ARE TRANSMITTED BY
WIRE TO THE LANGLEY COMPUTING FACILITY WHERE
THE INFORMATION IS STORED ON MAGNETIC TAPE
BEFORE PROCESSING. UP TO 40 SAMPLES PER SECOND
CAN BE TAKEN ON FORCE, PRESSURE OR TEMPERATURE
DATA WITH A 100 CHANNEL CAPACITY.



DRIVE FANS

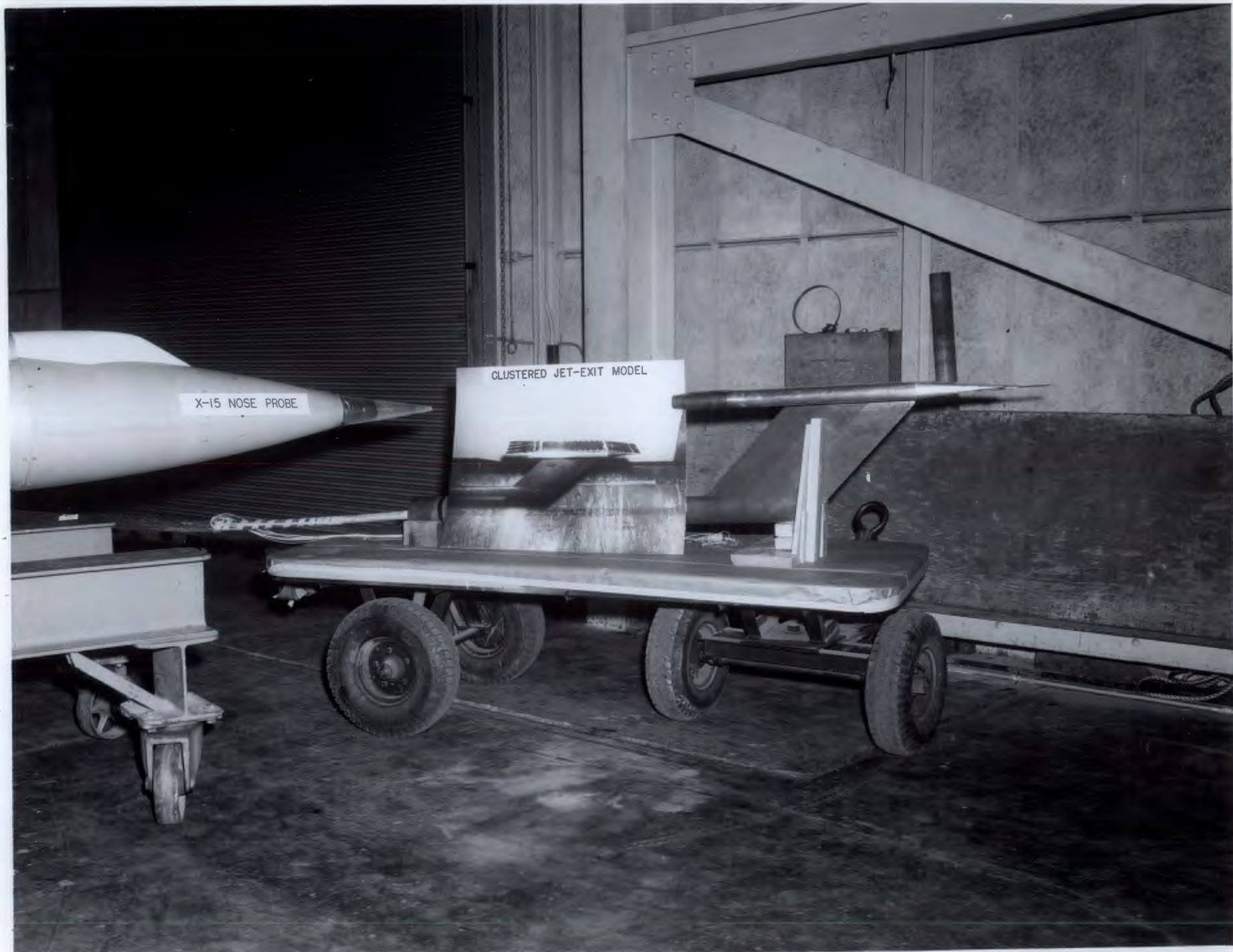
TWO STAGE-AXIAL FLOW - COUNTER ROTATING

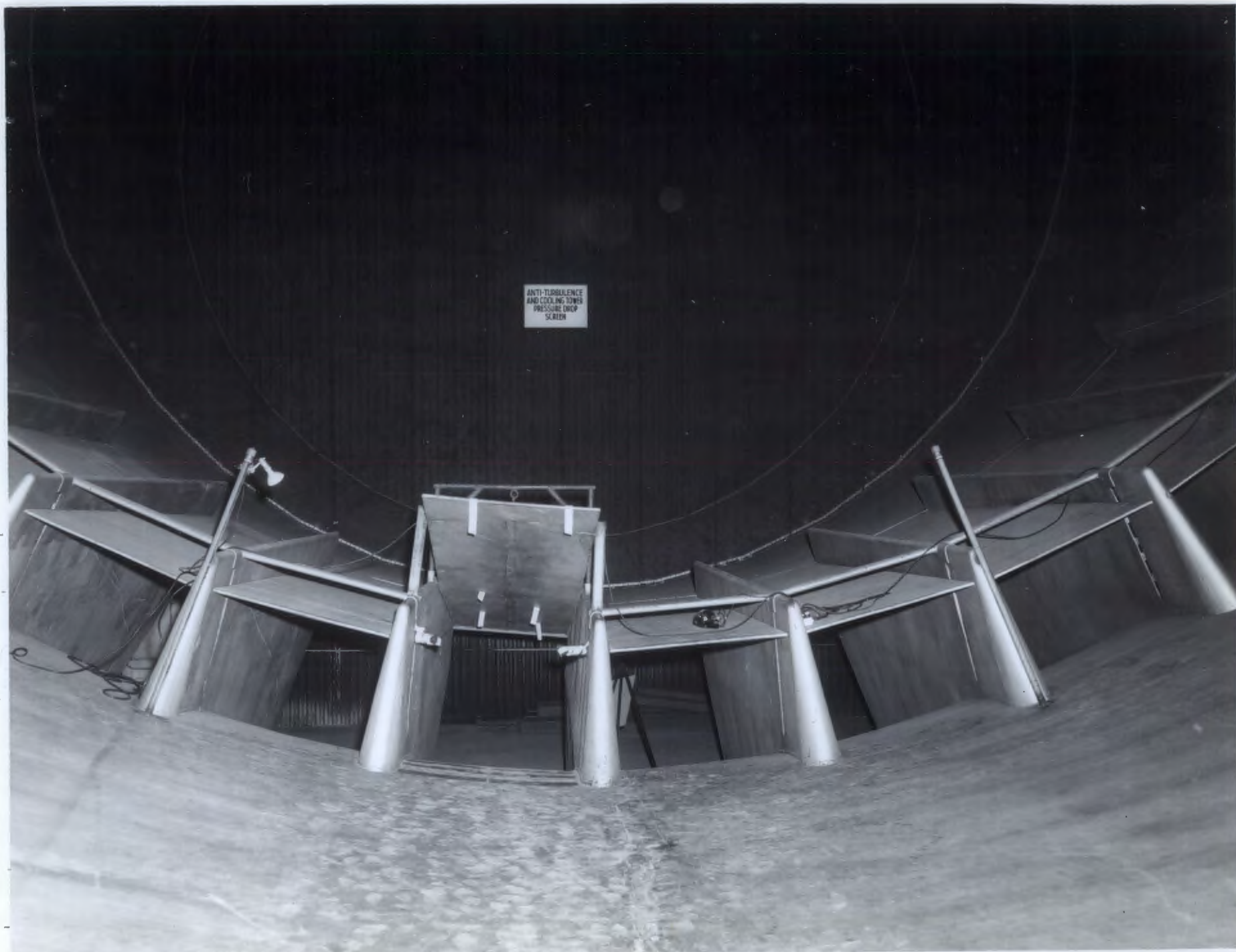
FAN DIAMETER	34 FEET
NACELLE DIAMETER	20 FEET
FIRST STAGE FAN	25 BLADES
SECOND STAGE FAN	26 BLADES
ROTATIONAL SPEED (MAX.)	372 RPM
TOTAL POWER (MAX.)	65,000 HP
TOTAL THRUST (MAX.)	126,000 LB
EFFICIENCY	95%

TEST SECTION AIR SPEED CONTROLLED BY DRIVE FAN SPEED
FAN BLADES MADE OF LAMINATED SPRUCE IN (NACA) NASA SHOPS

DRIVE SECTION STEELWORK BY W. W. S. D. D. CO.

NASA
L-64-5309



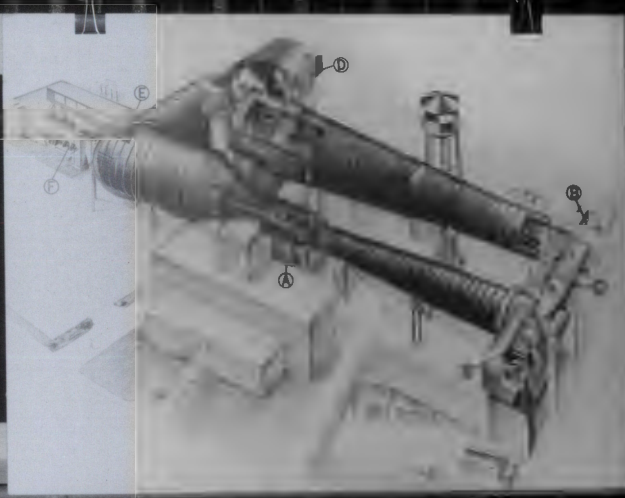


JET POWERED MODEL CONTROL STATION

THE HYDROGEN PEROXIDE MONOPROPELLANT ROCKET
JET SIMULATOR SYSTEM IS CONTROLLED FROM THIS
STATION. TURBOJET, TURBOFAN AND ROCKET MOTOR
PROPULSION NOZZLE EXHAUSTS IN MODELS ARE SIMULATED
WITH HYDROGEN PEROXIDE DECOMPOSITION GASES OR AIRFLOW
WITH THE FOLLOWING SYSTEMS :

1. H_2O_2 WITH FLOW RATES TO 5 LB/SEC UP TO 1000 PSI
2. H_2O_2 WITH FLOW RATES TO 15 LB/SEC UP TO 3000 PSI
4. AIRFLOW WITH FLOW RATES TO .3 LB/SEC UP TO 300 PSI
5. AIRFLOW WITH FLOW RATES TO 3 LB/SEC UP TO 1800 PSI

NASA
L-64-5313



1941 - 1950
RESEARCH ENGINE DESIGN AND ANALYSIS
PROPULSION
RESEARCH - ENGINE DESIGN, PROPELLANT FLOW
RESEARCH - ENGINE, CONTROL, FLUTTER



1950 - 1958
CONVENTIONAL TRANSPORT JET PROPULSION RESEARCH
RESEARCH - ENGINE DESIGN, PROPELLANT FLOW
RESEARCH - ENGINE, CONTROL, FLUTTER
EXPERIMENTAL, SUPERSONIC AIRCRAFT



1958 - 1966
SUPERSONIC CONVENTIONAL AIR TRANSPORT
RESEARCH - ENGINE DESIGN, PROPELLANT FLOW
RESEARCH - ENGINE, CONTROL, FLUTTER
EXPERIMENTAL, SUPERSONIC AIRCRAFT



NASA
L-64-5915

DANGER
VOLTAGE



SHORT TAKE-OFF AND
LANDING AIRPLANE

OBJECTIVE

THE PURPOSE OF THE CURRENT INVESTIGATION IS TO ENSURE THE SAFETY OF THE APOLLO CREW WHILE THIS SPACE VEHICLE IS BEING LAUNCHED.

IN CASE OF FIRE, EXPLOSION, OR LOSS OF BOOSTER CONTROL AT LAUNCH, THE ESCAPE ROCKETS HAUL THE APOLLO MODULE TO AN ALTITUDE FROM WHICH A SAFE DESCENT CAN BE MADE BY PARACHUTE.

THIS INVESTIGATION IS BEING MADE TO VERIFY STABLE FLIGHT OF THE APOLLO COMMAND MODULE IN THE ESCAPE TRAJECTORY.

MODEL IN TEST SECTION APOLLO COMMAND MODULE 1/12 SCALE (LUNAR MISSION VEHICLE)

INVESTIGATION OF ESCAPE ROCKET EXHAUST EFFECTS ON THE STABILITY OF THE APOLLO COMMAND MODULE.

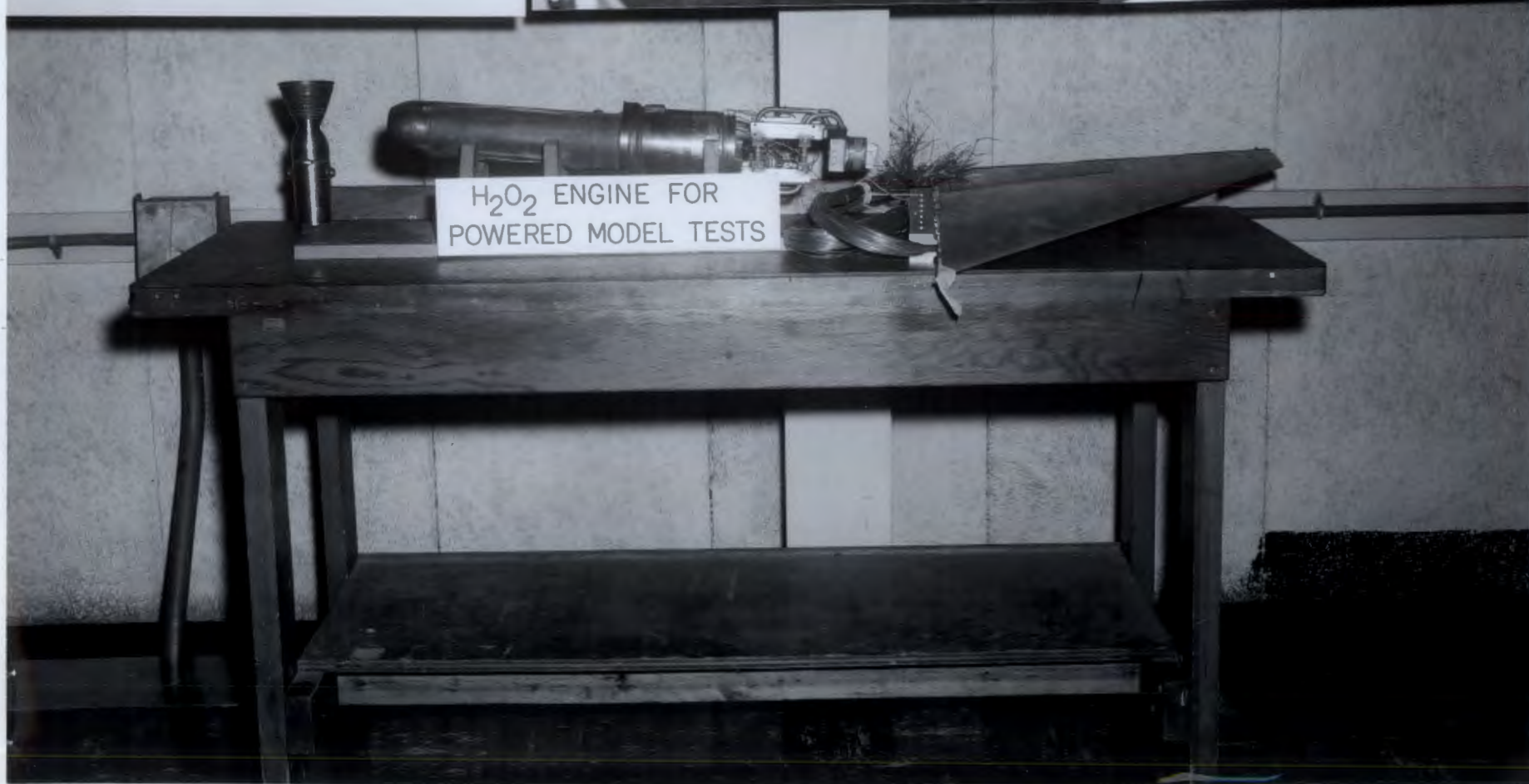
DURING TEST THE MODEL ESCAPE ROCKET MOTOR IS OPERATED WITH MONOPROPELLANT HYDROGEN PEROXIDE (90 PERCENT H_2O_2) TO PRESSURES OF 2000 PSI.

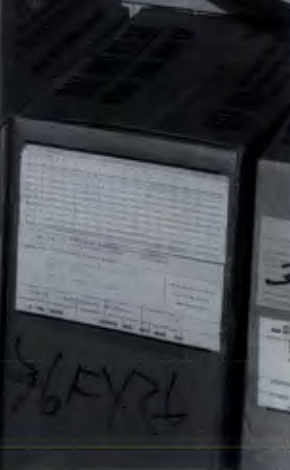
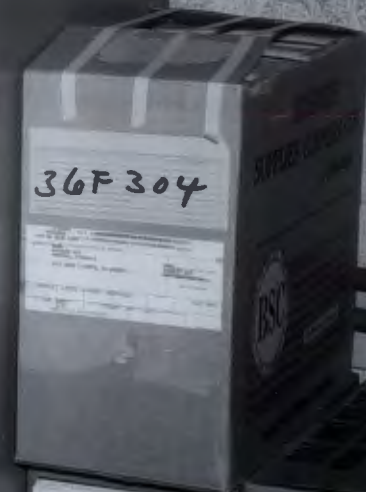
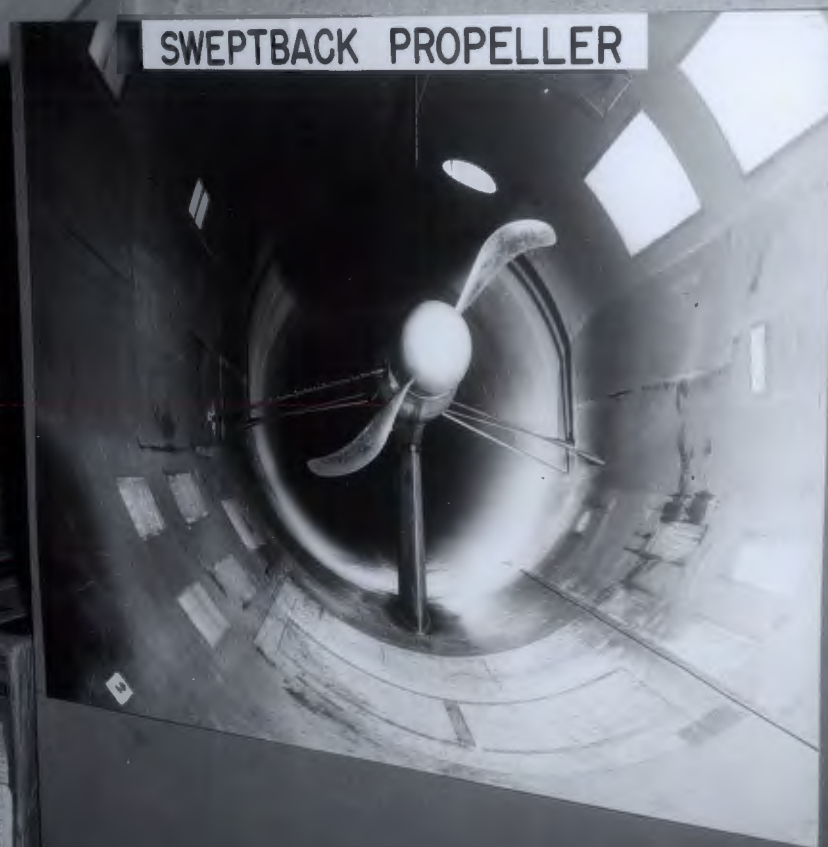
AIR SPEED, MODEL ATTITUDE, AND ROCKET MOTOR PRESSURE ARE VARIED AND THE EFFECTS ON STABILITY ARE MEASURED.





H₂O₂ ENGINE FOR
POWERED MODEL TESTS





W. 2000

R.P.
AIR

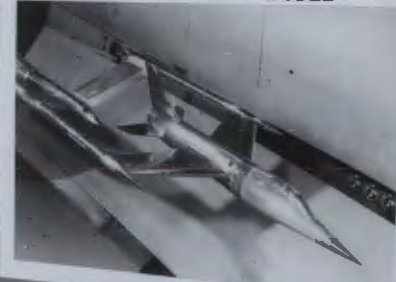
TRANSONIC JET-
EXIT MODEL WITH
PLUG NOZZLE

CONVERGENT DIVERGENT NOZZLES
FOR SUPERSONIC JET-EXIT MODEL

PYLON NACELLE JET-EXIT MODEL



F-11F-1 JET-EXIT MODEL



SATURN C-5 NOZZLE CLUSTER



EVOLUTION BOMB AERODYNAMICS MODEL



P6M-1 MODEL



SHADOWGRAPH OF P6M-1 MODEL
SHOWING SHOCK WAVES

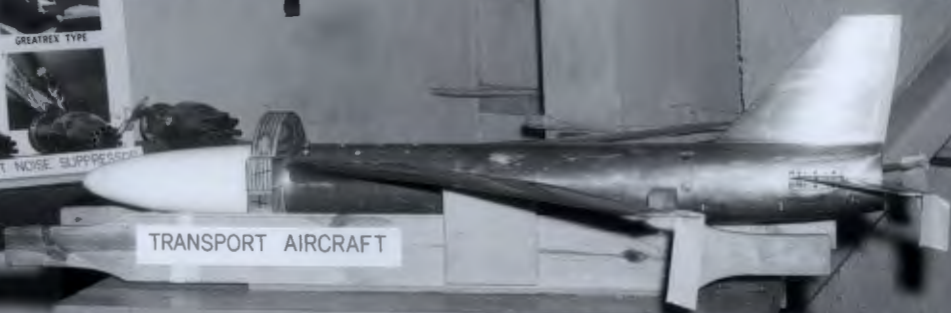


NOISE SUPPRESSOR CONFIGURATIONS



JET NOISE SUPPRESSOR

TRANSPORT AIRCRAFT



1941 - 1950

AIRCRAFT ENGINE COOLING AND COOLING
PROPELLERS
MOTOR - JETTED BOMBS, PROPELLITY PUMPS
AIRCRAFT - WINGS, COMBUSTORS, FLUTTER

X-1A AERODYNAMICS AND LOADS MODEL



F-104 STABIL



1950 - 1958

COMMERCIAL TRANSPORT JET POWERED AIRCRAFT
MILITARY AIRCRAFT FIGHTERS AND BOMBERS
SUPERSONIC PROPELLERS
TURBOJET PROPELLERS SYSTEMS
EXPERIMENTAL SUPERSONIC AIRCRAFT

TITAN I NOZZLE HINGE-MOMENT MODEL



DELTA V



1958 - 1964

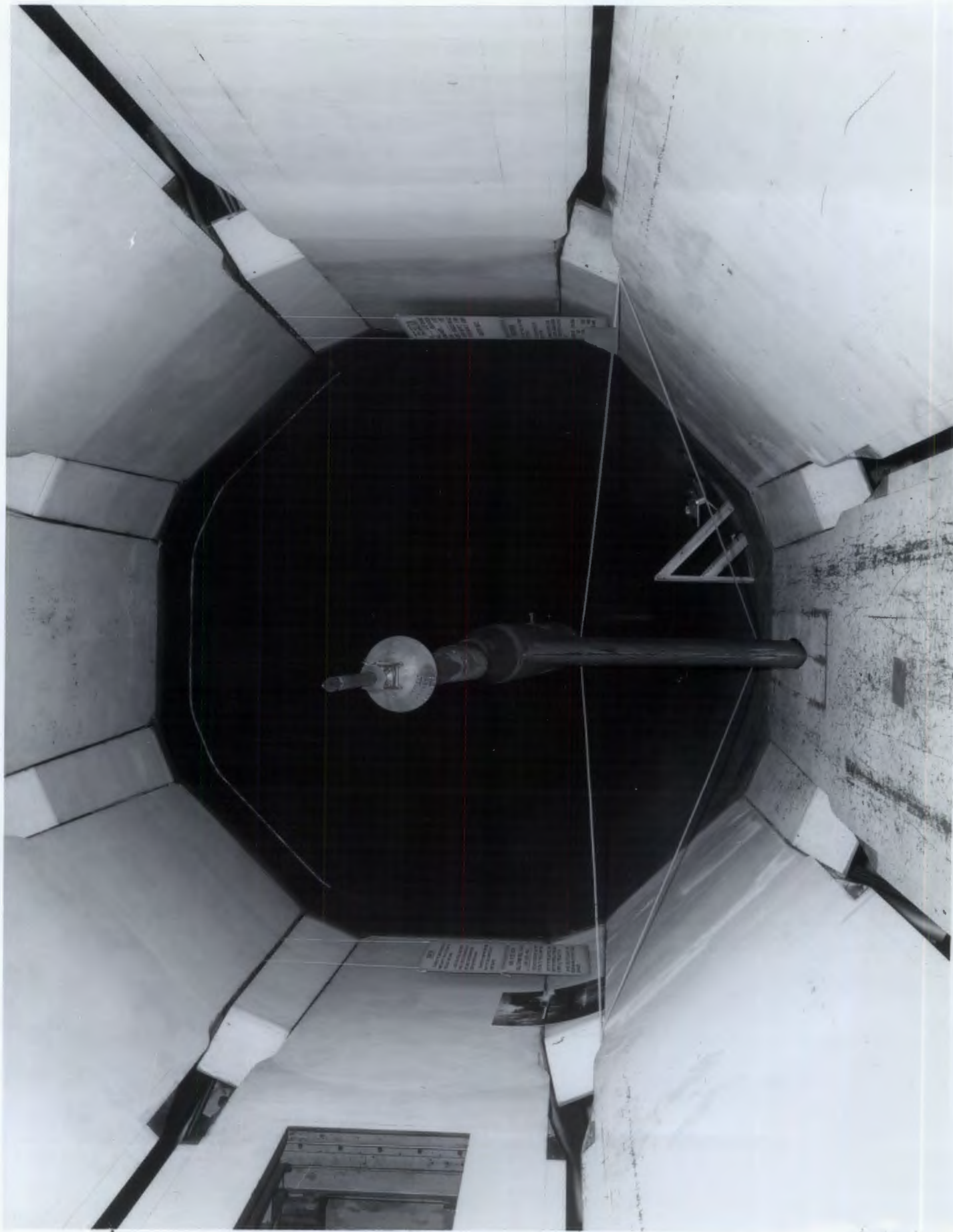
SUPERSONIC COMMERCIAL AIR TRANSPORT
MILITARY - ATTACK AIRCRAFT AND INTERCEPTORS
JET BUT NOZZLES - TURBOJET AND FAN ENGINES
WEAPONS - BALLISTIC MISSILES, BOMB FUSING
SPACE VEHICLE BOOSTERS (LAUNCH PHASE)
SPACE VEHICLES (LAUNCH AND REENTRY)

NASA
L-64-5323

80° TURNING JAWES
(SECOND SET)



NASA
L-64-5324



FORCE AND STRAIN

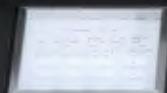
FORCES AND MOMENTS ARE MEASURED ON SCALED DOWN MODELS DURING WIND-TUNNEL TESTS TO DETERMINE THE AERODYNAMIC CHARACTERISTICS OF THE PROPOSED FULL-SCALE VEHICLES.

AN INSTRUMENT (CALLED A STRAIN-GAGE BALANCE) IS USED TO SENSE STRAINS CAUSED BY THE FORCES AND MOMENTS APPLIED TO THE MODEL. THE BALANCE TRANSFORMS THESE STRAINS INTO ELECTRICAL SIGNALS. FROM THESE TABULATED SIGNALS AND PREVIOUSLY OBTAINED CALIBRATION DATA, IT IS THEN POSSIBLE TO OBTAIN FORCE INFORMATION ON THE PROPOSED FULL-SCALE VEHICLES.



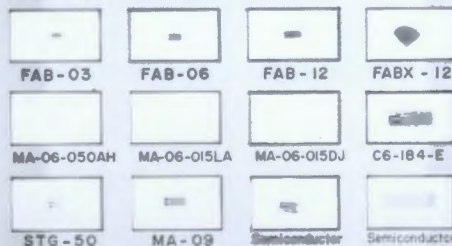
THE USE OF PHOTOELASTIC MATERIAL AND PHOTOELASTICITY HELPS TO ILLUSTRATE THE BEHAVIOR OF TYPICAL BALANCE SECTIONS. BELOW ARE SCALED-UP MODELS OF TWO FORCE MEASURING SECTIONS FREQUENTLY USED IN BALANCE DESIGN.

BY MOVING THE LEVER AT THE LEFT OF EACH MODEL, AS INDICATED BY THE ARROWS, A FORCE WILL BE APPLIED TO THE MODEL, SIMILAR TO THAT OCCURRING IN A BALANCE SECTION. THE COLOR CHANGES THAT OCCUR ARE A VISUAL ILLUSTRATION OF THE STRESS DISTRIBUTION IN THE RESOURCES. SINCE STRAIN IS PROPORTIONAL TO STRESS, RESISTANCE STRAIN GAGES, MOUNTED ON THE POINTS OF THE BEAM (AS INDICATED) WOULD YIELD AN ELECTRICAL SIGNAL, PROPORTIONAL TO THE TORSION EXPERIENCED BY THE BEAM.



STRAIN GAGES

The strain gages shown below are examples of the types and sizes used in stress analysis of complex structures and in precision force transducer work.



UNGAGED BALANCE
N 40[°] L 15[°]
A 7[°] Y 60[°]
P 80[°] S 20[°]

UNGAGED BALANCE
N 300[°] L 200[°]
A 30[°] Y 1000[°]
P 1000[°] S 300[°]

ABOV
OF TH
BY F
SKET
THE
WILL
AS T
PUSH
MAY
PLUS



AUTOMATIC TEMPERATURE CONTROL COATINGS FOR SPACECRAFT

PRINCIPLE: INVENT A COATING THAT WILL AUTOMATICALLY CONTROL THE TEMPERATURE OF A SPACECRAFT IRRESPECTIVE OF VARIATIONS IN SOLAR HEAT INPUT DUE TO CHANGES OF ORIENTATION OF THE SPACECRAFT RELATIVE TO THE SUN.

METHOD: USE A COATING THAT ABSORBS SOLAR HEAT AND WARMS UP THE SPACECRAFT WHEN IT IS TOO COLD, AND THEN REFLECTS THE SOLAR HEAT WHEN THE SPACECRAFT REACHES THE DESIRED TEMPERATURE.

THE COATING WARMS UP BY ABSORBING SUNLIGHT UNTIL THE CONTROL TEMPERATURE IS REACHED.

AT THE CONTROL TEMPERATURE THE COATING CHANGES AND REFLECTS THE SUNLIGHT, STOPPING THE TEMPERATURE RISE.

WHEN THE SUNLIGHT IS DECREASED THE COATING PARTLY CHANGES TO THE ABSORBING CONDITION AUTOMATICALLY MAINTAINING THE TEMPERATURE.



SIGNIFICANCE:

1. AUTOMATICALLY MAINTAIN TEMPERATURE OF SPACECRAFT AT DESIRED TEMPERATURE IRRESPECTIVE OF ORIENTATION OR DISTANCE FROM THE SUN.
2. OPERATES ON SPACECRAFT SURFACE TEMPERATURE AND THEREFORE ALLOWS ASTRONAUTS TO TRAVEL OUTSIDE THE EARTH'S ATMOSPHERE WITHOUT THE NECESSITY OF COMPLEX HEATING SYSTEMS.
3. HAS NO MOVING PARTS AND IS THEREFORE HIGHLY RELIABLE.
4. IS PROTECTIVE, MAINTAINING SPACECRAFT FROM EXCESSIVE HEAT IN UNDESIRABLE ORIENTATIONS AND FROM EXCESSIVE COLD IN OTHERS.

ECHO II PASSES VISIBLE FROM LANGLEY RESEARCH CENTER

DATE	TIME (EST)	DIRECTION	ELEVATION
MAY 19	2:54 A.M.	EAST	7°
MAY 20	4:14 A.M.	EAST	43°
MAY 21	3:14 A.M.	EAST	33°
MAY 22	3:23 A.M.	EAST	26°
MAY 23	2:57 A.M.	EAST	17°
MAY 24	NO VISIBLE PASSES		

ECHO I-PASSES VISIBLE FROM LANGLEY RESEARCH CENTER

DATE	TIME (EST)	DIRECTION	ELEVATION
MAY 19	1:00 A.M.	SE	66°
	2:00 A.M.	SE	66°
	3:00 A.M.	SE	66°
	4:00 A.M.	SE	66°
MAY 20	1:45 A.M.	SE	66°
	2:45 A.M.	SE	66°
MAY 21	1:45 A.M.	SE	66°
	2:45 A.M.	SE	66°
MAY 22	1:45 A.M.	SE	66°
	2:45 A.M.	SE	66°
MAY 23	1:45 A.M.	SE	66°
	2:45 A.M.	SE	66°
MAY 24	1:45 A.M.	SE	66°
	2:45 A.M.	SE	66°

SOLAR ENERGY COLLECTORS

PROBLEM - DEVELOP SPACECRAFT WITH
SOLAR ENERGY TO PROVIDE SPACE AND
MAXIMUM EFFICIENCY.

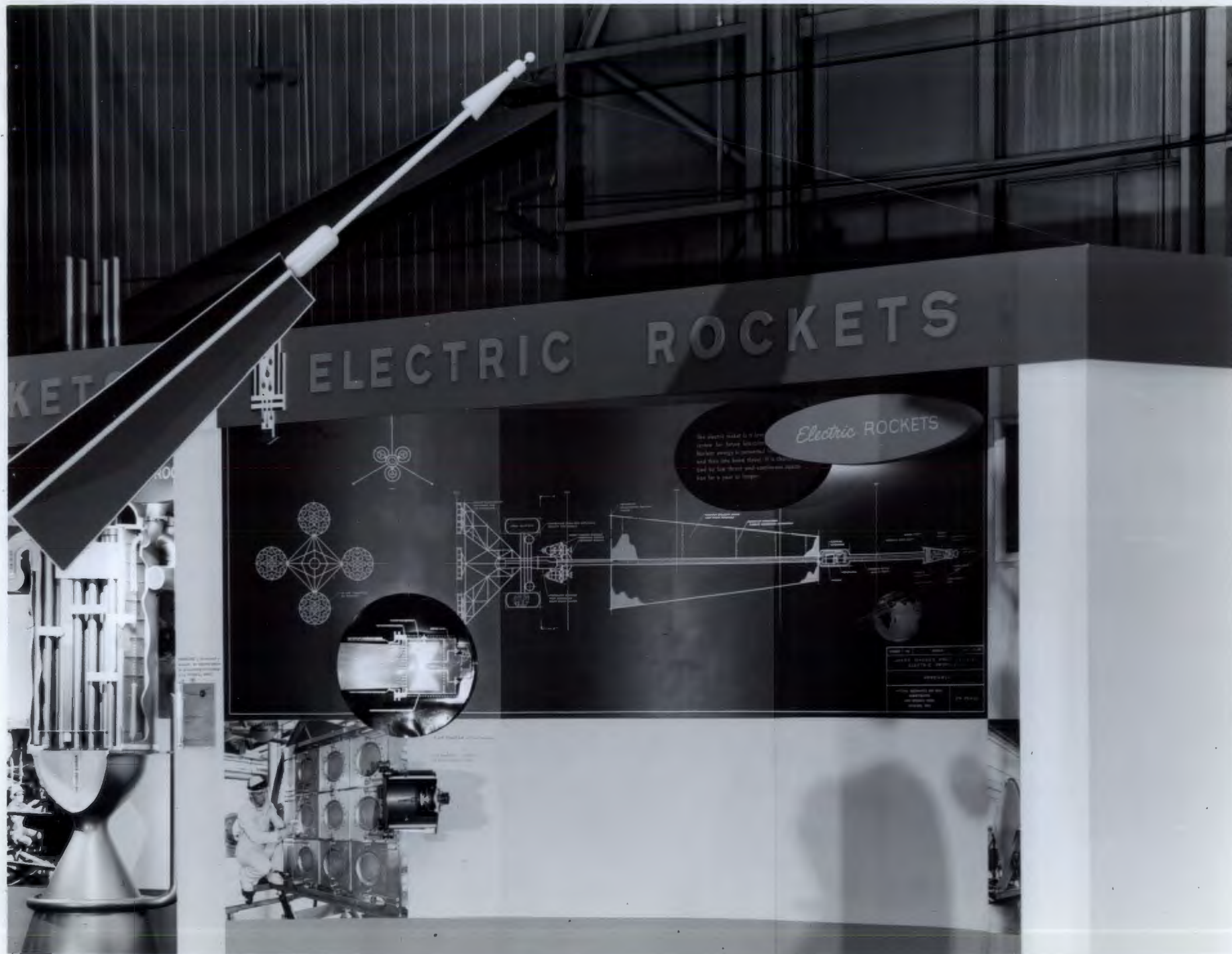
SOLUTION

1. USE SOLAR ENERGY TO PROVIDE SPACE AND
MAXIMUM EFFICIENCY.
2. COLLECT AND CONCENTRATE SOLAR ENERGY
BY REFLECTING COLLECTORS.
3. DEVELOP OPTIMUM REFLECTING COLLECTORS BY
A. MINIMIZE WEIGHT BY USE OF COLLAPSED
TUBES ERECTABLE IN SPACE.
B. MAXIMIZE COLLECTING AND CONCENTRATING
ABILITY BY USING REFLECTIVE SURFACES.
C. MAXIMIZE DURABILITY AND LIFETIME
BY USE OF MATERIALS THAT WITHSTAND
SPACE ENVIRONMENT.

SIGNIFICANCE

1. ELIMINATE NEED FOR TRANSPORTING FUEL
TO SPACE, FUEL OR CHEMICALS FOR PRO-
DUCING ELECTRICITY.
2. ELIMINATE HAZARD AND WEIGHT OF
NUCLEAR POWER.
3. CAN PROVIDE ELECTRIC POWER IN SPACE
INDEFINITELY.
4. CAN PROVIDE POWER UP TO KILOWATT
LEVELS.







AIR BREATHING ENGINES

Air Breathing ENGINES

Over 20 years has seen dramatic increases in the speed and thrust of air-breathing engines. The supersonic transport engines of 1960 will have developed air-breathing powerplants capable of the high-speed, sustained operation in a new research area.

COMMERCIAL TRANSPORT PROGRESS



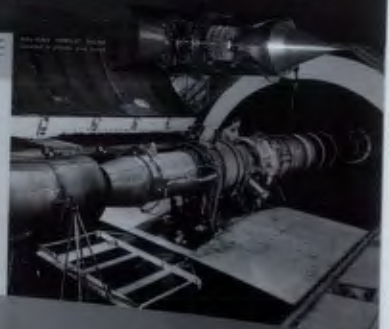
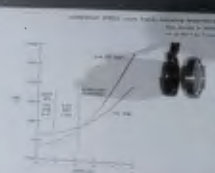
Light air-breathing engines
developed at the
Langley Research Center



The first jet engine
was developed at the
Langley Research Center



Small air-breathing engines
developed at the
Langley Research Center



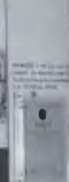
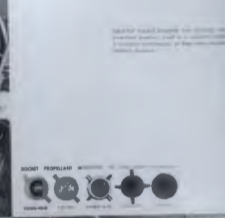
Small air-breathing engines
developed at the
Langley Research Center

Small air-breathing engines
developed at the
Langley Research Center



CHEMICAL ROCKETS

Chemical ROCKETS

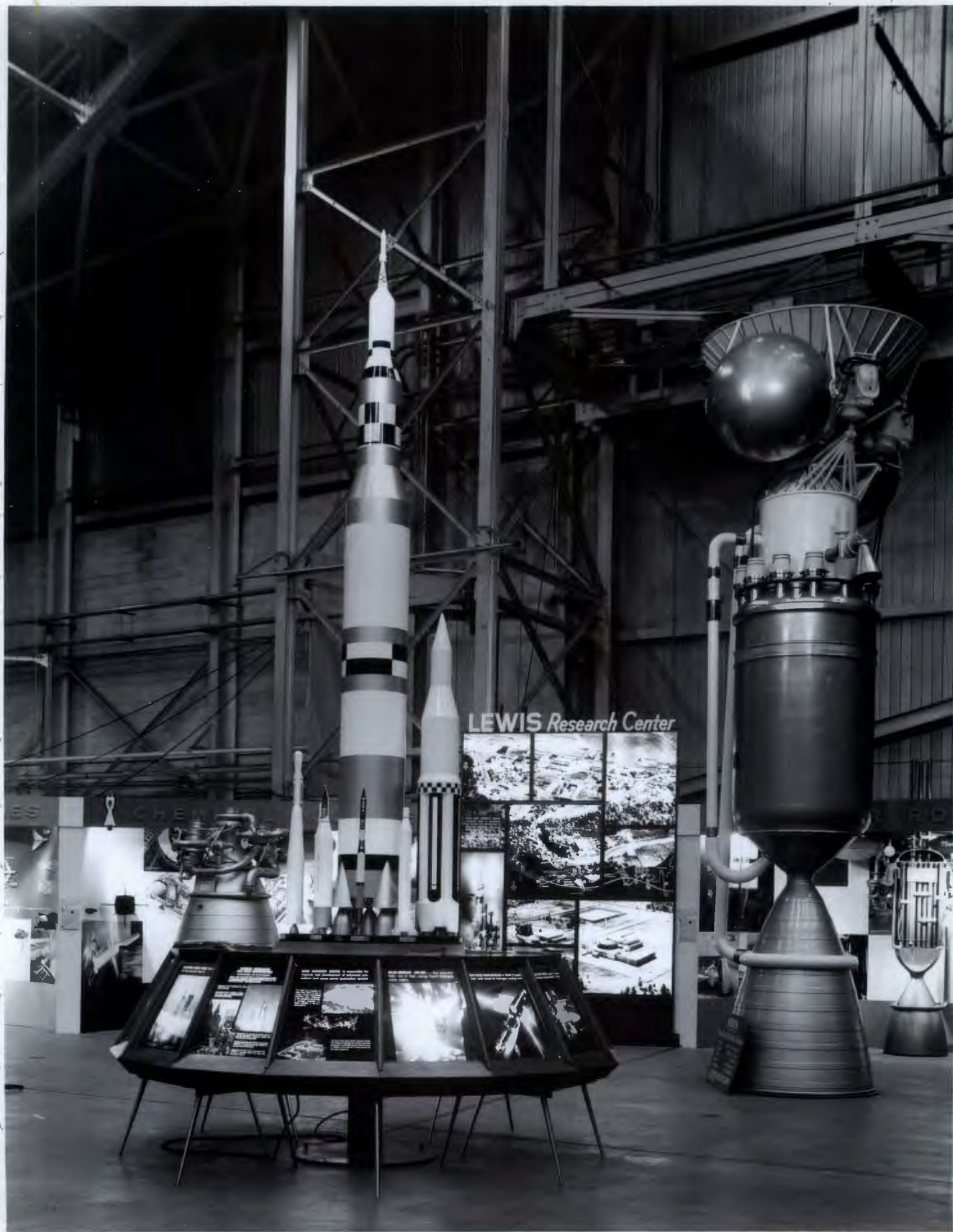


KNOWLEDGE is the end result of research. An important application for disseminating this knowledge is the TECHNICAL REPORT.

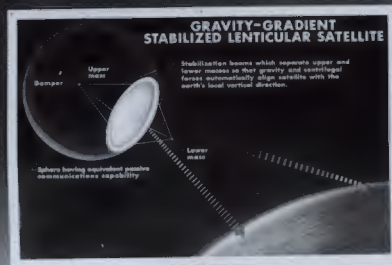


LEWIS Research Center





GRAVITY GRADIENT STABILIZED LENTICULAR COMMUNICATIONS SATELLITE



PROBLEM: MINIMIZE SIZE, WEIGHT, AND COMPLEXITY OF COMMUNICATIONS SATELLITES.

METHOD: UNDER STUDY

1. MAKE SATELLITE OF LENTICULAR SHAPE. THIS GIVES MAXIMUM REFLECTED SIGNAL FOR SIZE AND WEIGHT OF SATELLITE, BUT REQUIRES ORIENTATION TOWARD EARTH.
2. ORIENT LENTICULAR SATELLITE TOWARD EARTH BY GRAVITY-GRADIENT METHOD. THIS REQUIRES NO POWER OR JET CONTROLS, AND THEREFORE HAS UNLIMITED LIFE AT MAXIMUM RELIABILITY.

DISADVANTAGE: COMMUNICATIONS SATELLITE MUST BE ORIENTED TOWARD EARTH. THIS REQUIRES A SENSITIVE AND COMPLEX SYSTEM TO ORIENT THE SATELLITE. THIS SYSTEM MUST BE RELIABLE AND MUST BE ABLE TO ORIENT THE SATELLITE TOWARD EARTH IN ALL DIRECTIONS. THIS SYSTEM MUST BE ABLE TO ORIENT THE SATELLITE TOWARD EARTH IN ALL DIRECTIONS.



SOLAR ORIENTATION CONTROL SYSTEM

PLAN

PROJECT SOCS



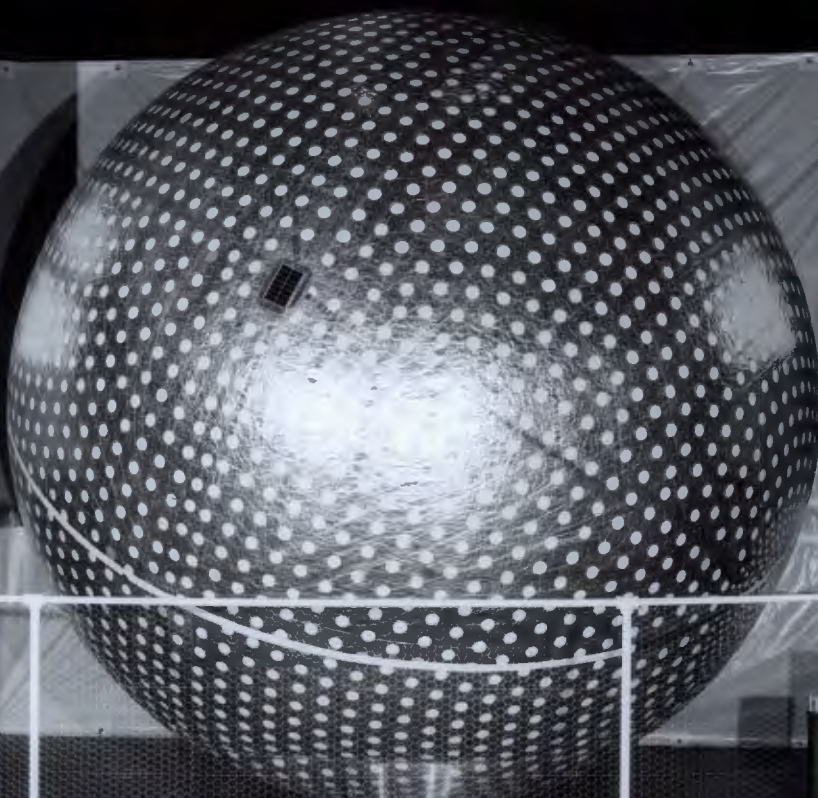
DESCRIPTION: The SOCS (Solar Orientation Control System) is a small, lightweight, and highly reliable spacecraft designed to demonstrate the feasibility of solar orientation control for spacecraft. It is a small, cylindrical spacecraft with a diameter of approximately 10 inches and a length of approximately 20 inches. It is designed to be launched by a small, expendable launch vehicle (ELV) and to operate in Earth orbit for a period of approximately 30 days. The spacecraft is designed to demonstrate the feasibility of solar orientation control for spacecraft by using a combination of solar sensors and a control system to maintain a constant orientation relative to the Sun.

CONFORMANCE: The SOCS spacecraft is designed to meet the following requirements:

1. Maintain a constant orientation relative to the Sun.
2. Operate for a minimum of 30 days.
3. Demonstrate the feasibility of solar orientation control for spacecraft.
4. Operate in Earth orbit.
5. Operate in a low Earth orbit.



ATMOSPHERIC DENSITY MEASUREMENTS AT SATELLITE ALTITUDES



PROBLEM: Measuring atmospheric density at satellite altitudes is a difficult task. The instrument used for this purpose is a spherical probe with a grid of small holes. The probe is designed to measure the density of the atmosphere at the altitude of the satellite.

METHOD: A spherical probe with a grid of small holes is used to measure the density of the atmosphere at the altitude of the satellite. The probe is designed to measure the density of the atmosphere at the altitude of the satellite.

RESULTS: The probe has been used to measure the density of the atmosphere at altitudes ranging from 100 to 1000 miles. The results show that the density of the atmosphere decreases rapidly with altitude.

AN DENSITY SATELLITE

1. MEASUREMENTS AT 10 TO 100 MILES ALTITUDE. EQUATORIAL AND TEMPERATE ZONES. 100 TO 1000 MILES ALTITUDE.

2. EXPLOSIONS AT 10 TO 100 MILES ALTITUDE. EQUATORIAL, TEMPERATE, AND POLAR ZONES. 100 TO 1000 MILES ALTITUDE.

3. AIR DENSITY DENSITY EXPLOSIONS. MEASUREMENTS OF DENSITY AND ATMOSPHERIC TEMPERATURE BY AN ALUMINUM BELT. 10 TO 100 MILES ALTITUDE. EQUATORIAL, TEMPERATE, AND POLAR ZONES. 100 TO 1000 MILES ALTITUDE.

PLASTIC MEMORY EFFECT

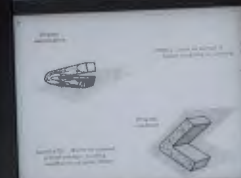
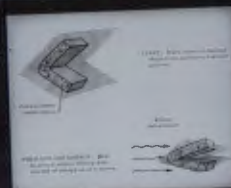
STATION KEEPING METHOD FOR LOW DENSITY SATELLITES

PROBLEM: DEVISE A MEANS OF ACCOMPLISHING MECHANICAL MOVEMENT OF A SPACECRAFT STRUCTURE OR COMPONENT WITH MINIMUM WEIGHT AND MAXIMUM RELIABILITY.

METHOD: USE ABILITY OF CERTAIN PLASTICS TO STORE MECHANICAL ENERGY AND RELEASE IT WHEN WARMED BY SOLAR RADIATION, RETURNING TO THEIR ORIGINAL SHAPE. THIS IS THE PLASTIC MEMORY EFFECT.

SIGNIFICANCE:

1. PROVIDES RELIABLE POWER FOR MECHANICAL MOVEMENT
2. PROVIDES FOLDABLE STRUCTURES THAT WILL RETURN TO THEIR ORIGINAL SHAPE
3. MAKES POSSIBLE FOLDABLE SPACECRAFT STRUCTURES THAT HAVE STORED IN THEM AT NO WEIGHT INCREASE THE MECHANICAL POWER TO RETURN TO THEIR ORIGINAL SHAPE IN SPACE



PROBLEM: TO DEVELOP THE THEORY OF OPERATION OF A LONG-LIFE ORBIT POSITIONING CONTROL SYSTEM FOR STATION KEEPING OF LOW-DENSITY SATELLITES WITHOUT THE EXPENDITURE OF MASS OR ENERGY IN ORDER TO PERFORM:

1. SATELLITE PLACEMENT - ACCURATELY PLACE SATELLITES INTO DESIRED ORBITS
2. STATION-KEEPING - MAINTAIN THE ALTITUDE AND PROPER SPACING BETWEEN SATELLITES
3. SATELLITE REPOSITIONING - CHANGE ORBITS OF SATELLITES AS REQUIREMENTS CHANGE WITH TIME
4. SATELLITE DISPOSAL - REMOVE FROM ORBITS WHEN SATELLITES BECOME OBSOLETE



THE SATELLITE'S ALTITUDE AND PERIOD CAN BE VARIED BY CHANGING THE ORBITAL ENERGY OF THE SATELLITE

METHOD: UTILIZATION OF SOLAR RADIATION PRESSURE TO ADJUST AND CONTROL ORBITAL POSITION BY VARYING THE SOLAR FORCE ON SATELLITE THROUGH ORIENTING DIFFERENT COATED SURFACE AREAS WHICH HAVE DIFFERENT OPTICAL PROPERTIES TOWARD THE SUNLIGHT DURING THE SATELLITE'S ORBIT. ORIENTATION TORQUES OBTAINED BY INTERACTION ON ELECTRIC COILS WITH THE GEOMAGNETIC FIELD (UNDER STUDY)

SIGNIFICANCE: STATION KEEPING, AS COMPARED TO RANDOMLY SPACING, GREATLY REDUCES THE NUMBER OF SATELLITES REQUIRED IN A CONTINUOUS WORLDWIDE ECHO-TYPE PASSIVE COMMUNICATION SATELLITE SYSTEM.



SATELLITES CAN BE ANGULARLY SPACED WITH RESPECT TO EACH OTHER BY ORBIT REPOSITIONING THROUGH SUCCESSIVE STEPS OF CHANGING ORBITAL PARAMETERS BY INCREASING AND THEN LATER DECREASING ORBITAL ENERGY

PLANET SEEKER FOR SPACECRAFT

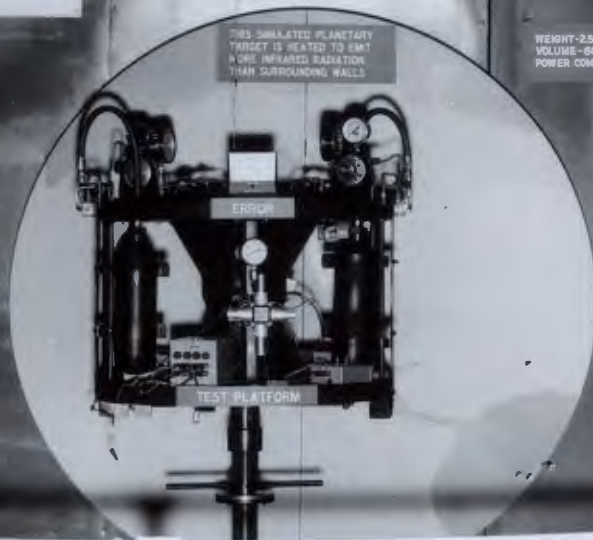
NASA
L-64-4847

PROBLEM: TO DETECT THE POSITION OF A
SIMULATED PLANETARY TARGET, WHICH
EMITS INFRARED RADIATION.

METHOD: USING THE PLANETARY TARGETING
SYSTEM OF THE PLANET SEEKER TO
DETECT THE POSITION OF THE
TARGET.

DESCRIPTION: THE PLANET SEEKER IS
A. A SIMULATED PLANETARY TARGET
B. A PLANETARY TARGETING SYSTEM
C. A PLANETARY TARGETING SYSTEM
D. A PLANETARY TARGETING SYSTEM
E. A PLANETARY TARGETING SYSTEM

THIS SIMULATED PLANETARY
TARGET IS HEATED TO EMIT
MORE INFRARED RADIATION
THAN SURROUNDING WALLS



PLANET SEEKER



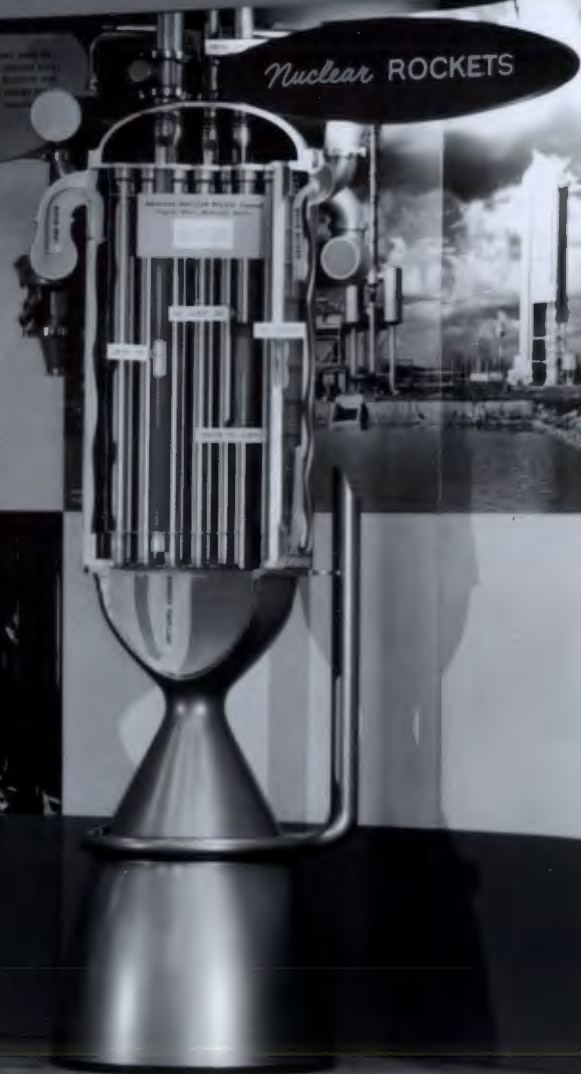
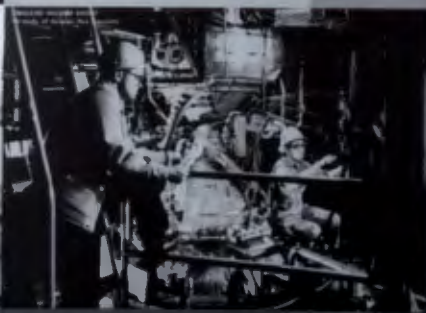
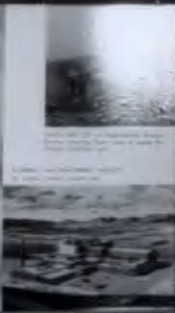
WEIGHT-25 LBS. ALTITUDE RANGE-50-500,000 MILES
VOLUME-60 CU. IN. ACCURACY-0.1 DEGREE
POWER CONSUMPTION-3.5 WATTS

PLANET SEEKER DETECTS EDGES
OF TARGET AND COMMANDS JET
CONTROL SYSTEM TO POINT
TEST PLATFORM TOWARD
CENTER OF TARGET

NUCLEAR ROCKETS



General Atomics Reactor
Advanced Reactor Development

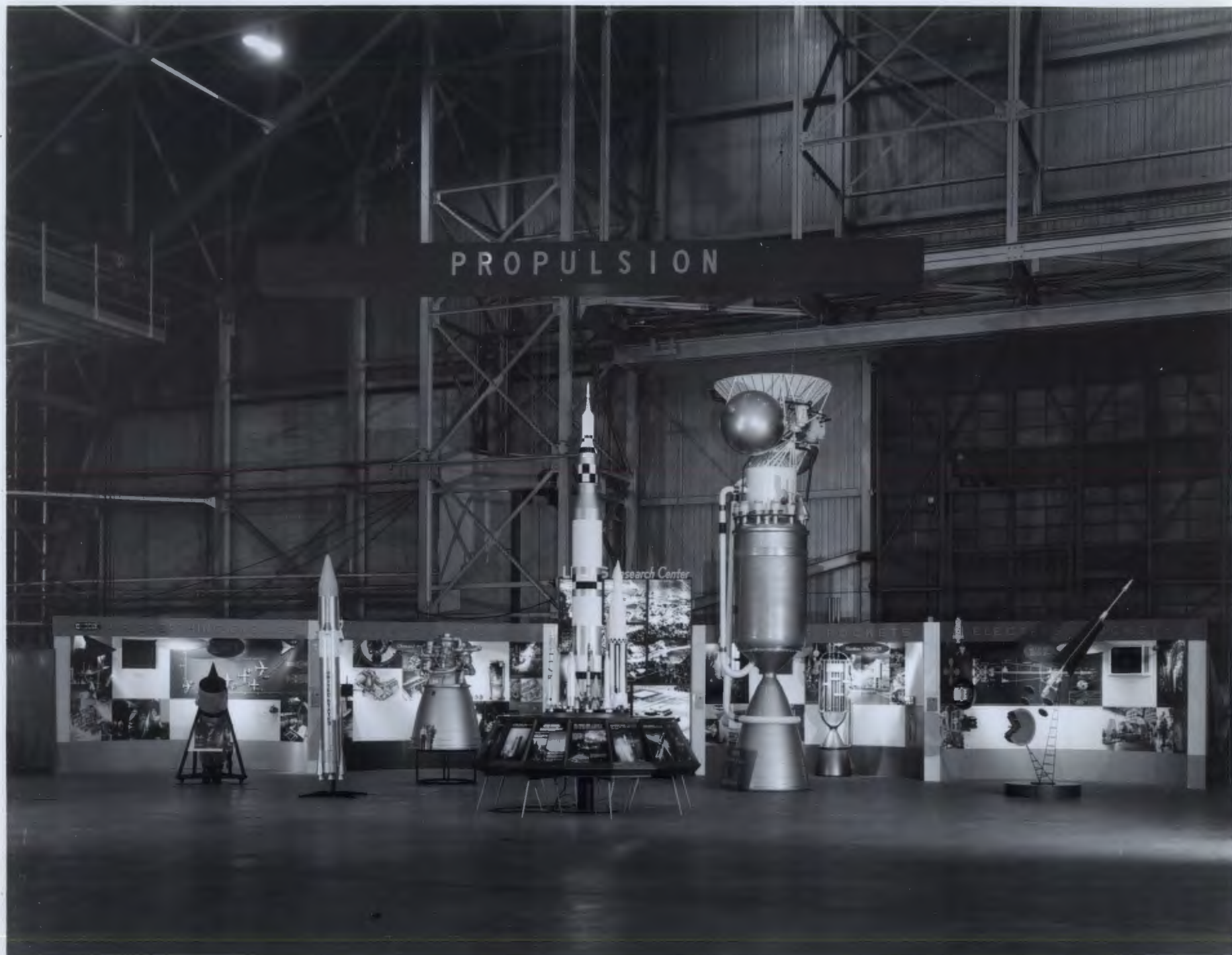


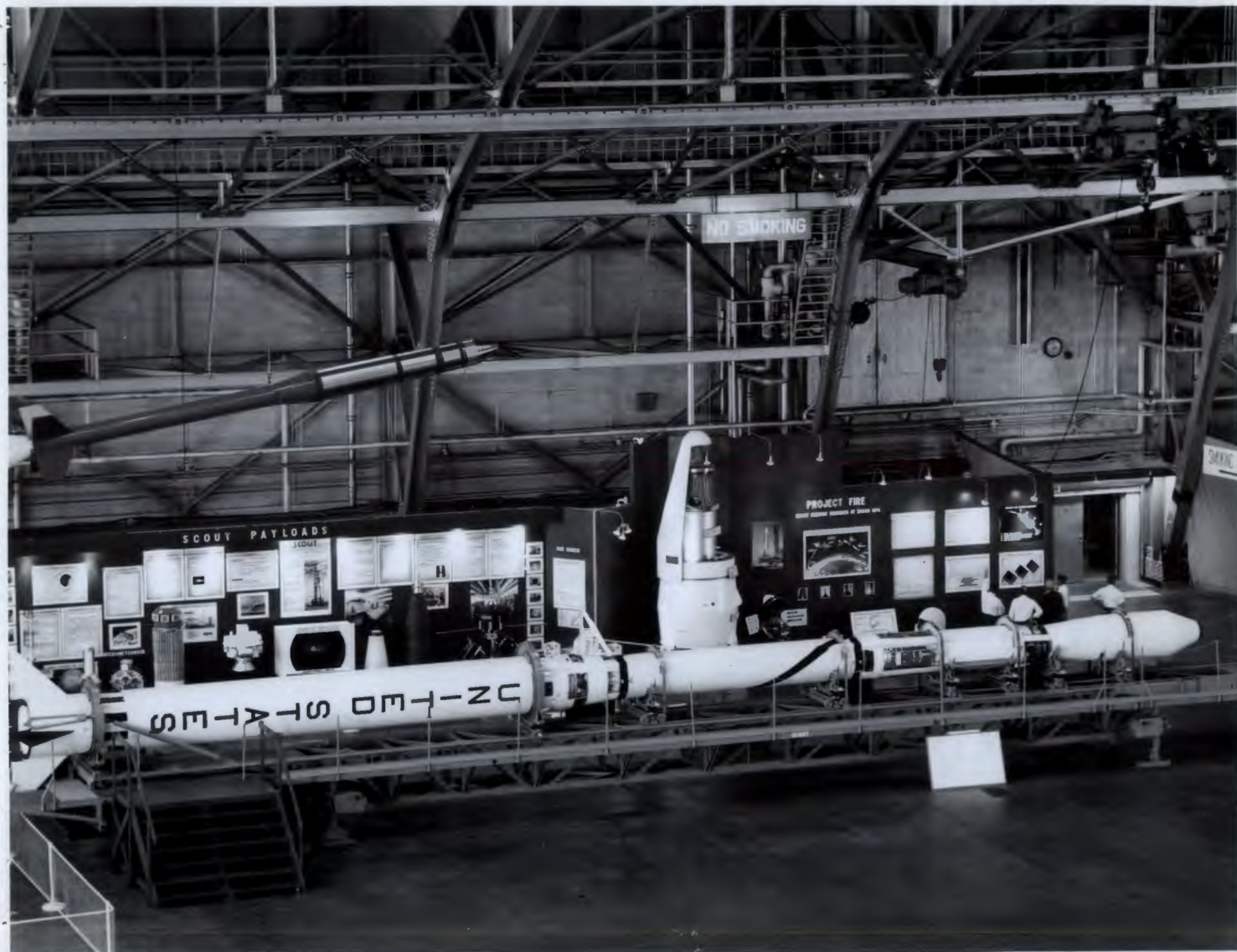
Nuclear ROCKETS

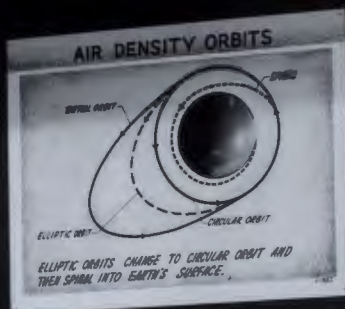


General Atomics Reactor
Advanced Reactor Development

PROPULSION







SCOUT CONFIGURATIONS

1987-1990 MODEL YEARS
WARRANTY 100 400 100 340 100

BASE (1987-1990)	\$1,499	
LEAD (1987-1990)	\$1,599	\$1,499
LEAD II (1987-1990)	\$1,599	\$1,599
LEAD III (1987-1990)	\$1,599	\$1,599
LEAD IV (1987-1990)	\$1,599	\$1,599
LEAD V (1987-1990)	\$1,599	\$1,599
LEAD VI (1987-1990)	\$1,599	\$1,599
LEAD VII (1987-1990)	\$1,599	\$1,599
LEAD VIII (1987-1990)	\$1,599	\$1,599
LEAD IX (1987-1990)	\$1,599	\$1,599
LEAD X (1987-1990)	\$1,599	\$1,599
LEAD XI (1987-1990)	\$1,599	\$1,599
LEAD XII (1987-1990)	\$1,599	\$1,599
LEAD XIII (1987-1990)	\$1,599	\$1,599
LEAD XIV (1987-1990)	\$1,599	\$1,599
LEAD XV (1987-1990)	\$1,599	\$1,599
LEAD XVI (1987-1990)	\$1,599	\$1,599
LEAD XVII (1987-1990)	\$1,599	\$1,599
LEAD XVIII (1987-1990)	\$1,599	\$1,599
LEAD XIX (1987-1990)	\$1,599	\$1,599
LEAD XX (1987-1990)	\$1,599	\$1,599
LEAD XXI (1987-1990)	\$1,599	\$1,599
LEAD XXII (1987-1990)	\$1,599	\$1,599
LEAD XXIII (1987-1990)	\$1,599	\$1,599
LEAD XXIV (1987-1990)	\$1,599	\$1,599
LEAD XXV (1987-1990)	\$1,599	\$1,599
LEAD XXVI (1987-1990)	\$1,599	\$1,599
LEAD XXVII (1987-1990)	\$1,599	\$1,599
LEAD XXVIII (1987-1990)	\$1,599	\$1,599
LEAD XXIX (1987-1990)	\$1,599	\$1,599
LEAD XXX (1987-1990)	\$1,599	\$1,599

INTERNATIONAL COOPERATIVE
IONOSPHERIC DEFINITION

S-66 ATMOSPHERIC BEACON

1. MAGNETIC MEASUREMENTS:
(a) DETERMINE THE TOTAL ELECTRON COUNT OF
A VERTICAL CROSS-SECTION OF THE MAGNETOSPHERE.

APPROX. ORBIT - 625 MILES

2-CIRCULAR POLAR CLOUT - CLOUT
- CLOUTING STATIONS.

3-OBSERVING STATIONS.

AROUND THE WORLD ON A VOLUNTARY BASIS.

SCOUT DEVELOPMENT ST-76
GODDARD PROBES P-218

OBJECTIVES

1. VEHICLE PERFORMANCE DATA

2-MEASUREMENT OF CHARGED PARTICLES

FROM EC:

RESULTS:
 EXCELLENT VEHICLE PERFORMANCE FOR BOTH DAY & NIGHT

EXCELLENT VALUE FOR MONEY
NIGHTTIME FLIGHTS

2. JOURNAL-ARTICLE IDENTITY PROFILES FOR NEW PUBLISHERS

(continued from page 1)



AIR DENSITY SATELLITES

EXPLORER IX.

LAUNCHED FROM HULLOOPS ISLAND ON
FEBRUARY 16, 1961. REENTERED EARTH'S
ATMOSPHERE AND BURIED UP ON APRIL 9, 1964.

EXPLORER III

LAUNCHED FROM PACIFIC MISSILE RANGE
ON DECEMBER 19, 1963.
EXPECTED LIFETIME 3 YEARS

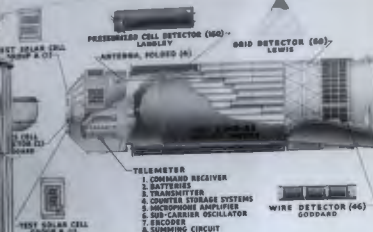
AIR DENSITY/INJUN EXPLODER
TO BE LAUNCHED FROM THE PAC
MISSILE RANGE IN 1984

INSTRUMENTATION

THE AIR DENSITY SATELLITES ARE SPHERICAL IN SHAPE AND HAVE AN EXCEEDINGLY LOW MASS-TO-FRONTAL-AREA RATIOS. THESE SATELLITES HAVE NO MEASURING INSTRUMENTS ON BOARD. THE SATELLITE ITSELF IS THE MEASURING INSTRUMENT FOR THE DETERMINATION OF THE ATMOSPHERIC DENSITY. THE ATMOSPHERIC DENSITY IS MEASURED BY THE RATE OF CHANGE OF THE SATELLITE ORBITS.



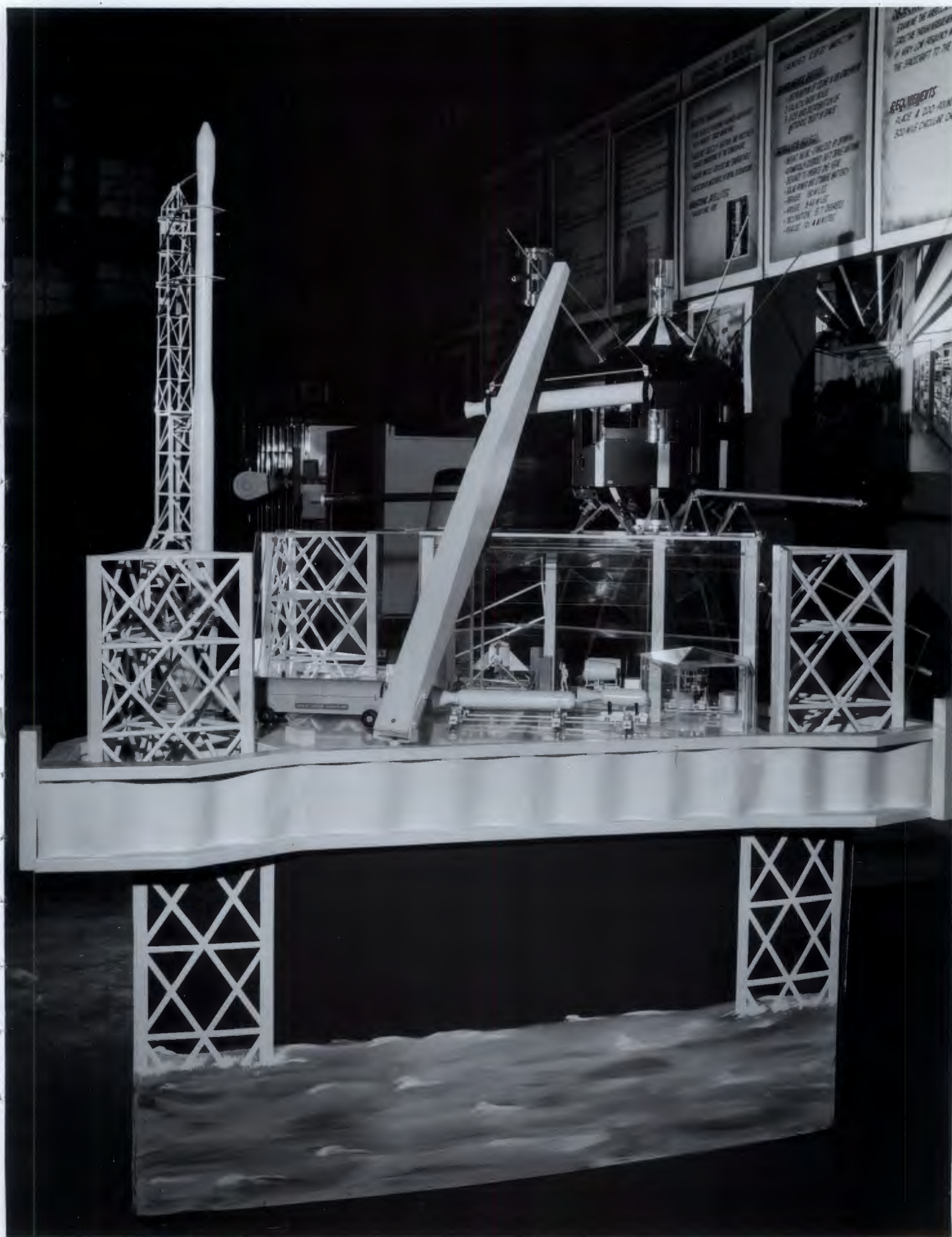
MICROMETEOROID SATELLITE (S-55)



MICROMETEOR

EXPLORER IX · XIX / INJUN

EXPLORER XIII-XVI



NASA
L-64-4816

SUPERCIRCULAR REENTRY

OBJECTIVE:

TO VERIFY THE PERFORMANCE OF AN ABLATION MATERIAL IN A HIGH ENTHALPY REENTRY ENVIRONMENT.

METHOD:

WITH A FIFTH STAGE 17-INCH DIAMETER NOSE VACUUM SPHERE. NOSE, FOURTH AND FIFTH STAGES ARE TRULUSTIN IN DESCENT.

PROGRAMMED:

LAUNCH: ANGLE - 80°
MAXIMUM ALTITUDE - 66,000 FEET-END THIRD-STAGE COAST
AT MAXIMUM TIME - 507.000000 - 350,000 FEET
AT 215.327777000 - FIFTH-STAGE DESCENT

ATOMIC ENERGY COMMISSION REENTRY FLIGHT (RFD-2)

PURPOSE:

INVESTIGATE EXPERIMENTALLY THE DISSEMINATION OF AN INERT WISDOMED SNA-10 OUTSIDE REENTRY
INTERMEDIATE THE HISTORY OF THE ELEMENT COMPOUND
REENTRY HEATING
INVESTIGATE REENTRY AERODYNAMIC HEATING IMPACT
IN THE SNA-10 REENTRY
IMMEDIATE FLIGHT TEST RESULTS WITH ANALYTICAL
PREDICTIONS AND EXPERIMENTALLY ANALYZED REENTRY DATA.

OBJECTIVES:

RECOVERY OF THE PAYLOAD IS REQUIRED
2. DETAIL TRAJECTORY PROFILE.



DEPARTMENT OF DEFENSE SCIENTIFIC MISSIONS

GEODETIC MEASUREMENTS:

1-THE STUDY OF RESONANCE HAZARDS ASSOCIATED WITH AIRCRAFT SHORT CIRCUITS
2-MEASURE DIRECTLY NEUTRAL AND POSITIVELY CHARGED COMPOUNDS OF THE ATMOSPHERE
3-MEASURE AIRCRAFT DENSITY AND TEMPERATURES
4-DETECTION OF ANISOTROPIES IN ORBITAL DISTRIBUTIONS

NAVIGATIONAL SATELLITES:

1-NAVIGATIONAL AIDE



ARIEL II

ANGLO-AMERICAN SCIENTIFIC SATELLITE

LAUNCHED: 12.39 EST MARCH 17, 1964

EXPERIMENTS (BRITISH)

1-DISTRIBUTION OF COSMIC IN OUR ATMOSPHERE
2-GALACTIC AND NOISE
3-SIZE AND DISTRIBUTION OF METEORIC DUST IN SPACE

SATELLITE (AEC)

• WEIGHT: 100 LBS - STABILIZED BY SPINNING
• AUTOMATICALLY EXTENDED SUFFICIENT ANTENNAE
• DESIGNED TO OPERATE ONE YEAR
• SOLAR POWER AND STORAGE BATTERY
• PERIOD: 100 MINUTES
• ALTITUDE: 10,000 MILES
• INCLINATION: 51.7 DEGREES
• PERIOD: 101.4 MINUTES

FR-FRENCH SPACECRAFT

OBJECTIVE:

EXAMINE THE IRREGULARITIES OF BAROSPHERIC STRUCTURE THROUGH MEASUREMENT OF THE CORRELATIONS OF VERY LOW-FREQUENCY WAVES PROPAGATE FROM THE SPACECRAFT TO THE GROUND.

REQUIREMENTS:

PLACE A 200-POUND PAYLOAD IN A 500-MILE CIRCULAR ORBIT.



SA

SM-1

OBJECT
1-PERFORM
AN ORBIT
2-EXPERIMENT
OF THE
3-TAKE AN
EQUATION
SAY AN

REQUIRE
1-PLACE
SUFFICIENT
EQUATION
APPROX

NASA

REENTRY

AEC

UNITED KINGDOM-ARIEL II

SAN MARCO

SM-1 ITALIAN SPACECRAFT

OBJECTIVE:

- 1-PERFORM A CONTINUOUS MEASUREMENT OF THE AIR DENSITY OF AN EQUATORIAL ORBIT.
- 2-EXPLORE THE ATMOSPHERIC CHARACTERISTICS OF THE ATMOSPHERE.
- 3-TRAIN AN ITALIAN LAUNCHING CREW FOR THE EQUATORIAL LAUNCHING FROM THE MOBILE SAN MARCO PLATFORMS.

REQUIREMENTS:

- 1-PLACE A 250-POUND PAYLOAD (28-INCH DIAMETER SPHERE) IN AN ELLIPTICAL EQUATORIAL ORBIT (PERIGEE-125 MILES - APOGEE-575 MILES).

1/20 SCALE MODEL SCOUT
SANTA RITA LAUNCH PLATFORM
INDIAN OCEAN

SCOUT PAYLOADS

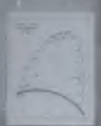
SCOUT DEVELOPMENT ST-7 & ST-9 GODDARD PROBES D-21 & D-21A

OBJECTIVES:

1. VEHICLE PERFORMANCE DATA
2. MEASUREMENT OF CHARGED PARTICLE DENSITY AND THE UPPER ATMOSPHERE (DURING AND AFTER FLIGHT)

RESULTS:

1. EVALUATION VEHICLE PERFORMANCE FOR DATA - DATA AND MANEUVERING FLIGHTS.
2. CHARGED PARTICLE DENSITY MEASUREMENTS FOR DATA AFTER FLIGHTS (RESULTS AVAILABLE BY JOURNAL OF SUPPLEMENTAL RESEARCH)



SERT - I

OBJECTIVE:

1. TO DEMONSTRATE THE FEASIBILITY OF ION BEAM NEUTRALIZATION.
2. TO OBTAIN ENGINE OPERATING DATA REQUIRED TO EVALUATE ION ENGINE PERFORMANCE.

MANAGER:

LEWIS RESEARCH CENTER



SCOUT

WEIGHT: 39,000 POUNDS

LENGTH: 72 FEET

TAKEOFF THRUST:

104,000 POUNDS

MAXIMUM DIAMETER:

40 INCHES

STAGES: 4

TYPE:

SOLID PROPELLANT

DEVELOPER: LANGLEY RESEARCH CENTER

PRIME CONTRACTOR: LING-TENCO-VOUGHT

MISSIONS:

EXPLORERS II, III, XVI, XVII, ARIEL II
REENTRY-NASA & AEC PROBES



SUPERCOOL

OBJECTIVE:

TO VERIFY THE EFFECT OF MATERIAL IN A

METHOD:

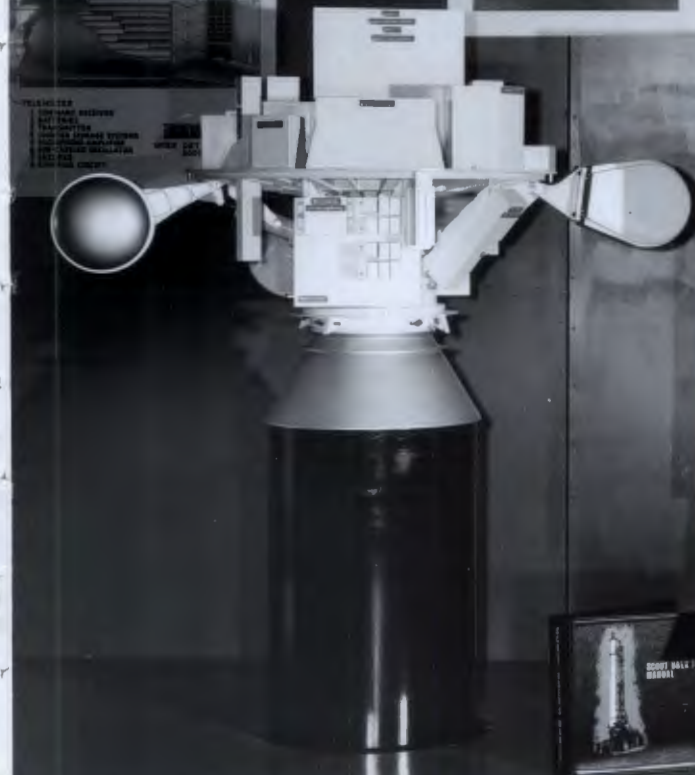
WITH A FIRST STAGE MOTOR FOURTH

PROGRAMME:

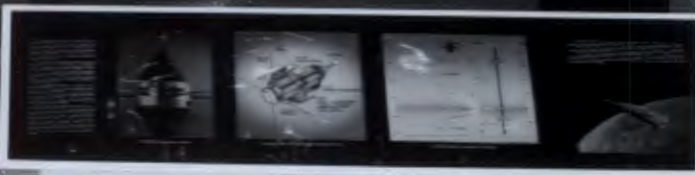
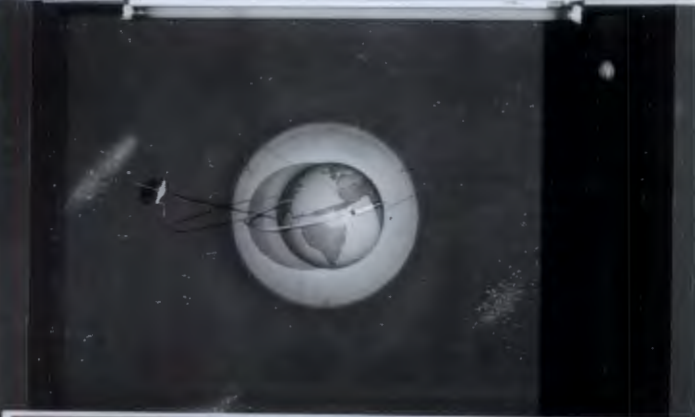
LAUNCH AND MAXIMUM ALTITUDE AT MAXIMUM TIME

PROJ D SATELLITE (S-55)

REDS CELL DETECTOR (S-55)
LEWIS



SERT





OPTICAL TRACKING

NASA
L-64-5329

PROVIDES DATA ON
SMALL HIGH-SPEED
RESEARCH VEHICLES
WHICH RADARS CAN-
NOT TRACK.

TO DETERMINE:

- POSITION
- VELOCITY
- ACCELERATION
- EVENTS
- TEMPERATURES



SUBE TRACK FOR PRECISION
POSITION DATA



PREPARED TRACK FOR ACCEL-
ERATION AND VELOCITY DATA



SPECTROGRAM FOR BURNING
PRODUCTS AND TEMPERATURE
DATA



TYPICAL SITES IN OPERATIONAL
STATUS

BALLOON CAMERA
LOW SPEED
INTERNAL METER ELECTRONICALLY OPER-
ATED AND REMOVED TO
REPLACE FILM
EXTERNAL METER MOUNTED ON BALLOON
FOR PHOTOGRAPHY
A BALLOON CAMERA OPERATED BY
MANUAL AND ELECTRONICALLY OPERATED TO
REPLACE FILM REMOVED TO
REPLACE FILM



MULTI-STATE TRACKING CAMERA
LOW SPEED
SHUTTER SPEED - 1/1000 SEC
EXPOSURE RATE - 2 TO 1000
FILM SIZE - 35mm
ELECTRONICALLY OPERATED TO
REPLACE FILM REMOVED TO
REPLACE FILM



THE BALLOON CAMERA IN OPERATION

MICROELECTRONICS

RESEARCH, DEVELOPMENT AND EVALUATION IN PHYSICAL
AND CHEMICAL ELECTRONICS TO IMPROVE RELIABILITY AND
PERFORMANCE OF SPACECRAFT INSTRUMENTATION

RESEARCH AND DEVELOPMENT

DEVELOPMENT OF ELECTRO CERAMIC
THIN FILM CIRCUITS

SCREEN CIRCUIT PROCESS STEPS

SCHEMATIC

LAY OUT

PHOTOREDUCE



FORM MASK

PRINTING

FIRE

ENCAPSULATE



EVALUATION

ALL TECHNOLOGIES

FLIGHT ENVIRONMENT

PERFORMANCE TEMPERATURE

SHOCK



PACKAGED ASSEMBLIES



PROTOTYPE

WORKING MODEL OF TELEMETRY SUBSYSTEM

ANALOG TO DIGITAL CONVERTER

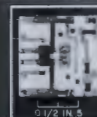
DELAY



SCHMITT
TRIGGER



COMPARATOR



LADDER ADDER



OR GATE



ANALOG-TO-DIGITAL CONVERTER
BLOCK DIAGRAM



FLIP FLOP

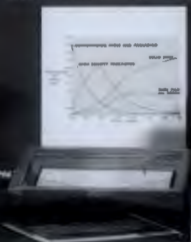


MINIATURIZATION
AFFECTS UPON

RELIABILITY

REENTRY VELOCITY

PREDICTION OF USAGE

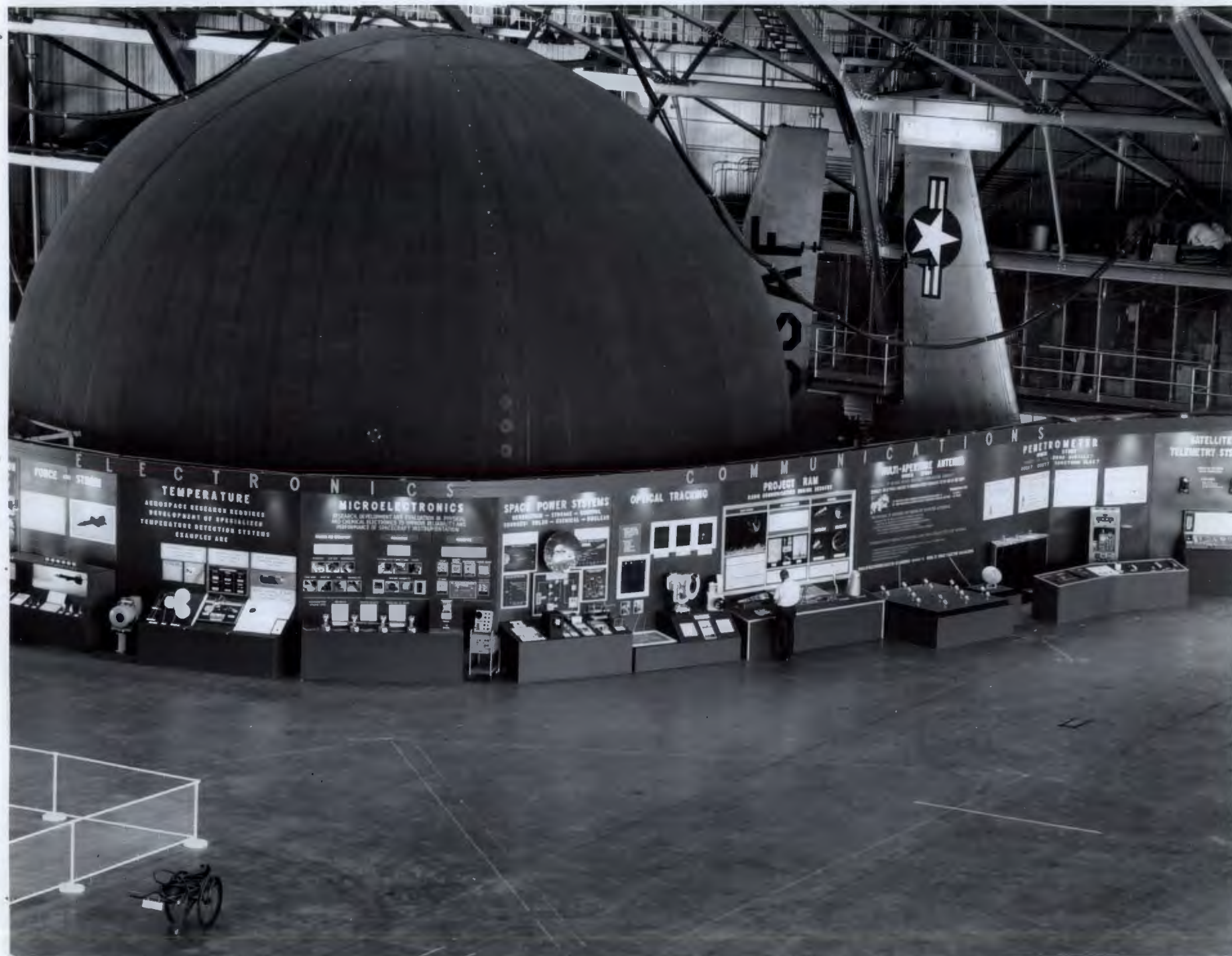


SP
G
SOU

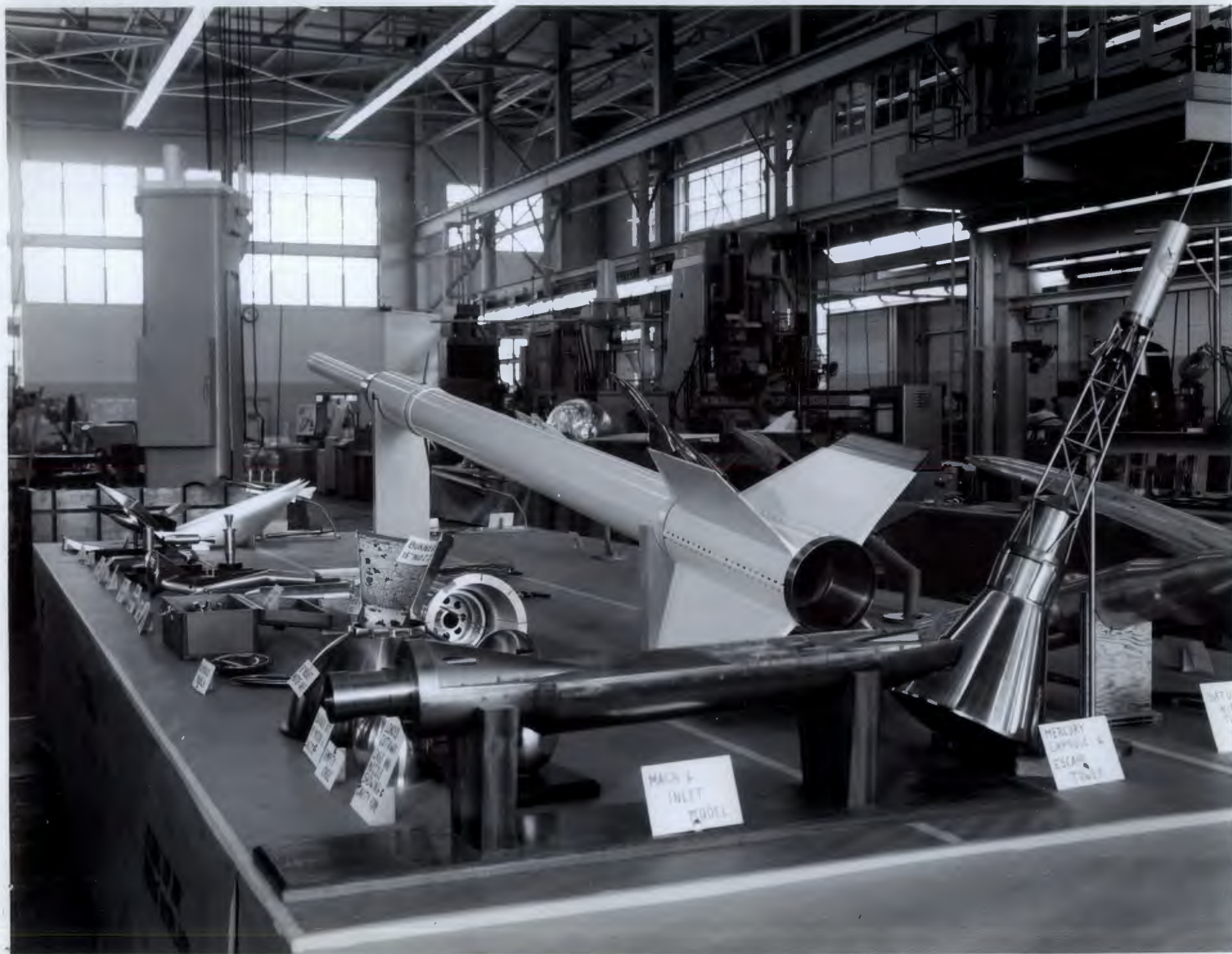
SOLAR CELLS A
SOLAR ENERGY
RELIABLE, BUT
MUST BE PROVI

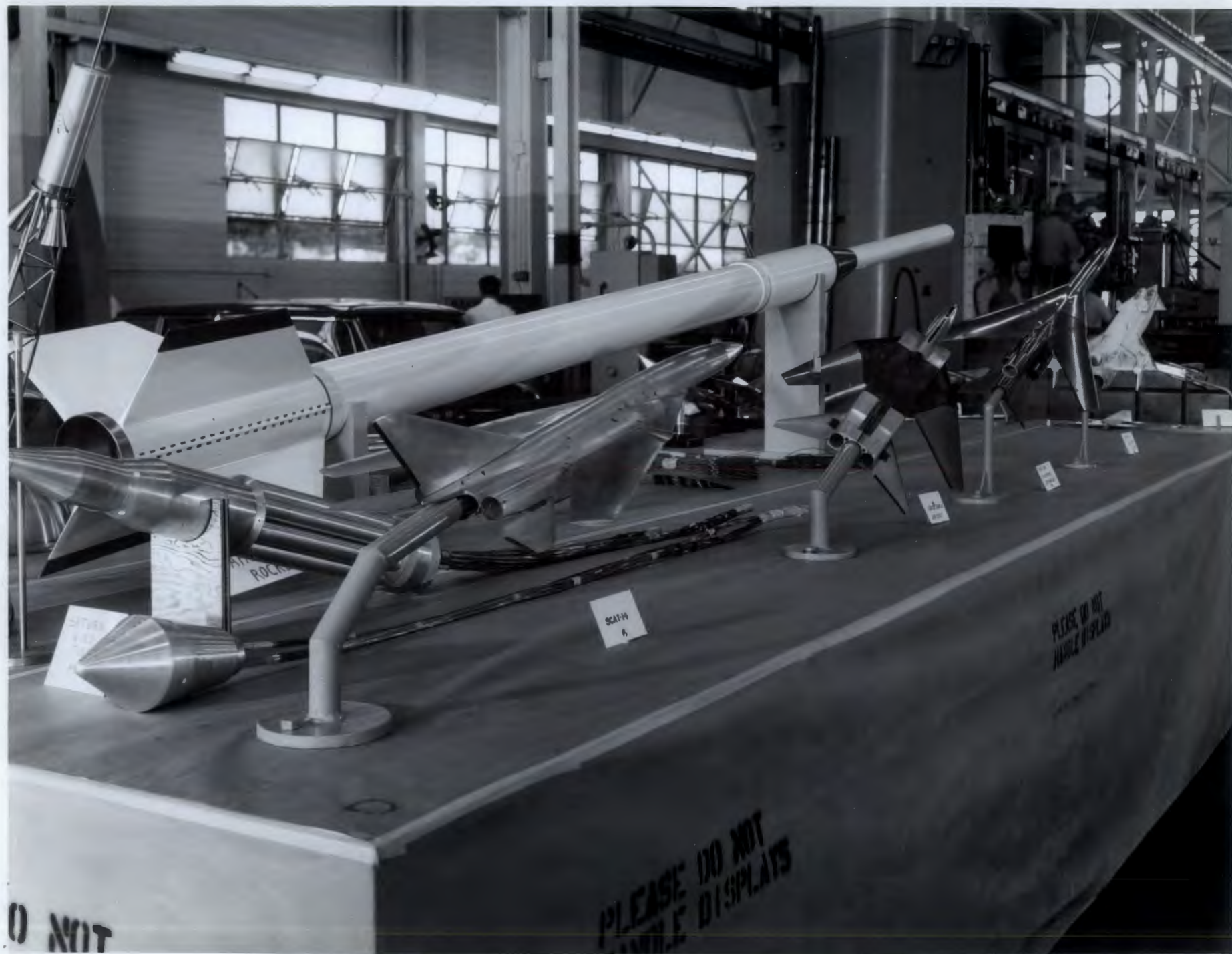


RELIATION



NASA
L-04-4879





NASA
L-84-4881



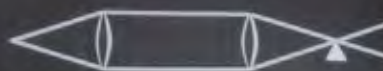
FLOW VISUALIZATION

AERODYNAMIC INVESTIGATIONS REQUIRE A THOROUGH KNOWLEDGE OF AIR FLOW AROUND VEHICLES
VARIATION IN AIR DENSITY CAUSES LIGHT PATH TO BE ALTERED — OPTICAL TECHNIQUES USE THIS PHENOMENA TO VISUALIZE AIR FLOW & SHOCK PATTERNS

SHADOWGRAPH



SCHLIEREN



INTERFEROMETR



LASER

ITS POLARIZED.
NOCHROMATIC. HIGH-
ENSITY LIGHT. LIGHT
CUSSED TO A POINT.

COLLIMATING LENS

RENDERS LIGHT PARALLEL
THROUGH THE TEST SECTION.

FOCUSING LENS

REFOCUSES LIGHT ON A
SPECIAL PRISM.

PRISM AND POLAROID

PRISM SHEARS OR DISPLACES
LIGHT LATERALLY TO FORM TWO
BEAMS. POLAROID ALLOWS
INTERFERENCE TO BE VIEWED.

SCREEN

FRINGE SHIFTS IN THE ABOVE
INTERFEROGRAM INDICATE
AIR DENSITY VARIATIONS IN
THE CONVECTIVE FLOW
AROUND THE HEATED MODEL.



NASA
L-64-5301

TEMPERATURE

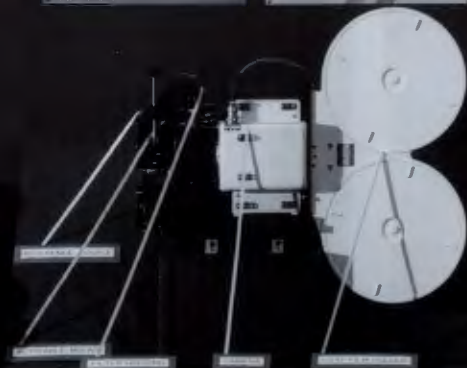
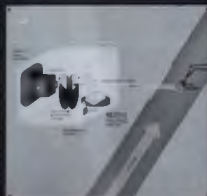
AEROSPACE RESEARCH REQUIRES DEVELOPMENT OF SPECIALIZED TEMPERATURE DETECTION SYSTEMS

EXAMPLES ARE

PHOTOGRAPHIC PYROMETER FOR HIGH SURFACE TEMPERATURE

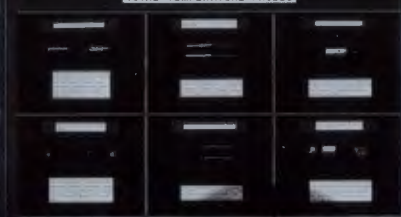
A VARIABLE EXPOSURE PHOTOGRAPHIC PYROMETER

THIS IS AN INSTRUMENT WHICH CAN RECORD
TIME-RESOLVED SURFACE TEMPERATURE CON-
TOURS IN THE RANGE 1800°-4500°K. THE
CAMERA DISCOVERS THE TEST MODEL, THEN
INCREASINGLY DENSE CONTOUR-ROTATING FILTERS
FOR A GIVEN TEMPERATURE (INTENSITY). THERE
EXISTS A FILTER VALUE, DURING ONE REVOLUTION
OF THE FILTERS, WHICH YIELDS A PROPERLY RE-
SPONSIVE PHOTOGRAPH. A REFERENCE SOURCE IS
PHOTOGRAPHED IN THE SAME MANNER IN ORDER TO
CALIBRATE THE INSTRUMENT. THE RESULTING
FILM DENSITIES AND THEIR ASSOCIATED FILTER
VALUES YIELD TEMPERATURES WITH A
PRECISION OF 3% FOR MOST APPLICATIONS.

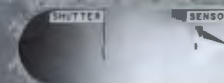


SENSORS FOR GAS TEMPERATURE & HEAT FLOW

TOTAL TEMPERATURE PROBES



FAST RESPONSE HEAT TRANSFER MEASURING SYSTEM



APOLLO CAPSULE IN SHORT TEST TIME FACILITY TO STUDY REENTRY HEATING

IN ACTUAL FACILITY TESTS, THIS HEATING IS CAUSED BY CONVECTIVE
AND RADIATIVE HEAT TRANSFER FROM THE SURROUNDING AIR. HERE
WE SIMULATE THIS BY USING AN ORDINARY HAIR DRYER.

THE FAST RESPONDING HEAT SENSOR CONVERTS MODEL
SURFACE TEMPERATURE INTO AN ELECTRICAL SIGNAL
WHICH IS DISPLAYED ON THE OSCILLOSCOPE
SCREEN TO THE LEFT.

TO OPERATE:

1. WAIT FOR RED LIGHT TO COME ON...
2. PUSH BUTTON UNTIL LIGHT GOES OFF...
3. OBSERVE TWT AND SHUTTER ACTION AND
WATCH RESULTS ON OSCILLOSCOPE...



FAST RESPONSE HEAT TRANSFER MEASURING SYSTEM

NASA
L-64-5347



APOLLO CAPSULE IN SHORT TEST TIME FACILITY TO STUDY REENTRY HEATING

IN ACTUAL FACILITY TESTS, THIS HEATING IS CAUSED BY CONVECTIVE AND RADIATIVE HEAT TRANSFER FROM THE SURROUNDING AIR. HERE WE SIMULATE THIS BY USING AN ORDINARY HAIR DRYER.



THE FAST RESPONDING HEAT SENSOR CONVERTS MODEL SURFACE TEMPERATURE INTO AN ELECTRICAL SIGNAL WHICH IS DISPLAYED ON THE OSCILLOSCOPE SCREEN TO THE LEFT.

TO OPERATE:

- 1. WAIT FOR RED LIGHT TO COME ON...***
- 2. PUSH BUTTON UNTIL LIGHT GOES OFF...***
- 3. OBSERVE TUFT AND SHUTTER ACTION AND WATCH RESULTS ON OSCILLOSCOPE...***

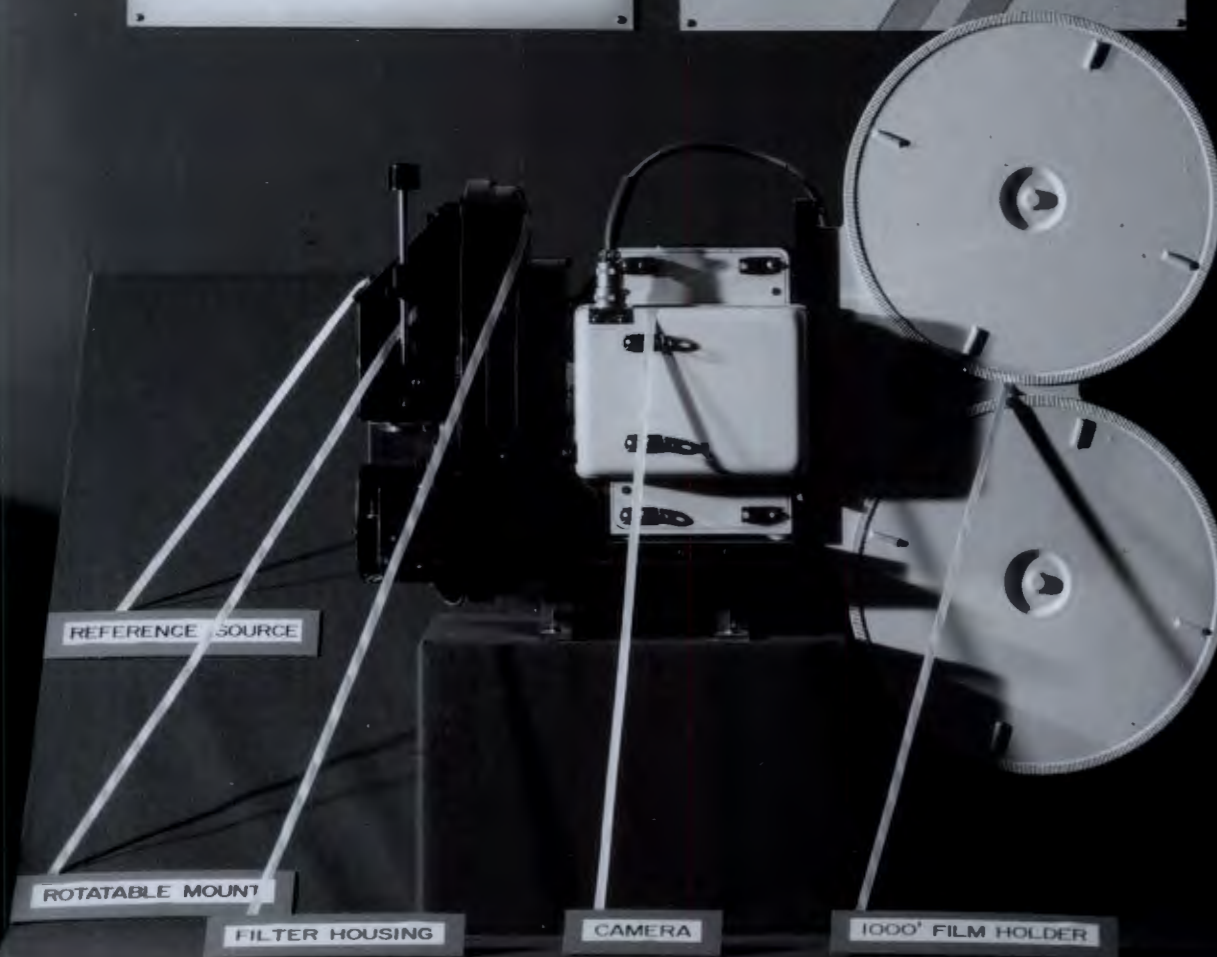
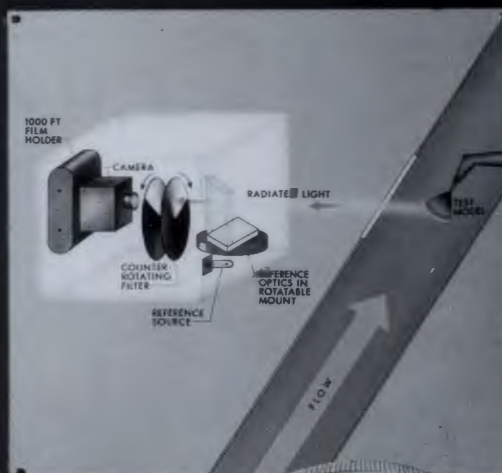


PHOTOGRAPHIC PYROMETER FOR HIGH SURFACE TEMPERATURE

NASA
L-64-5348

A VARIABLE EXPOSURE PHOTOGRAPHIC PYROMETER

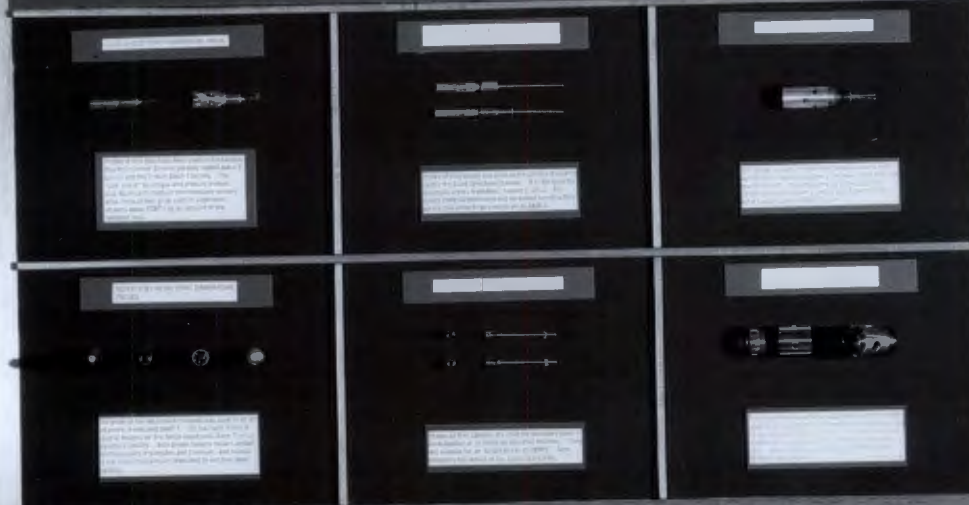
THIS IS AN INSTRUMENT WHICH CAN RECORD TIME-RESOLVED SURFACE TEMPERATURE CONTOURS IN THE RANGE 1800°F-4500°F. THE CAMERA OBSERVES THE TEST MODEL THRU INCREASINGLY DENSE CONTRA-ROTATING FILTERS. FOR A GIVEN TEMPERATURE (INTENSITY), THERE EXISTS A FILTER VALUE, DURING ONE REVOLUTION OF THE FILTERS, WHICH YIELDS A PROPERLY EXPOSED PHOTOGRAPH. A REFERENCE SOURCE IS PHOTOGRAPHED IN THE SAME MANNER IN ORDER TO CALIBRATE THE INSTRUMENT. THE RESULTING FILM DENSITIES AND THEIR ASSOCIATED FILTER VALUES RENDER TEMPERATURES WITH A PRECISION OF 2% FOR MOST APPLICATIONS.



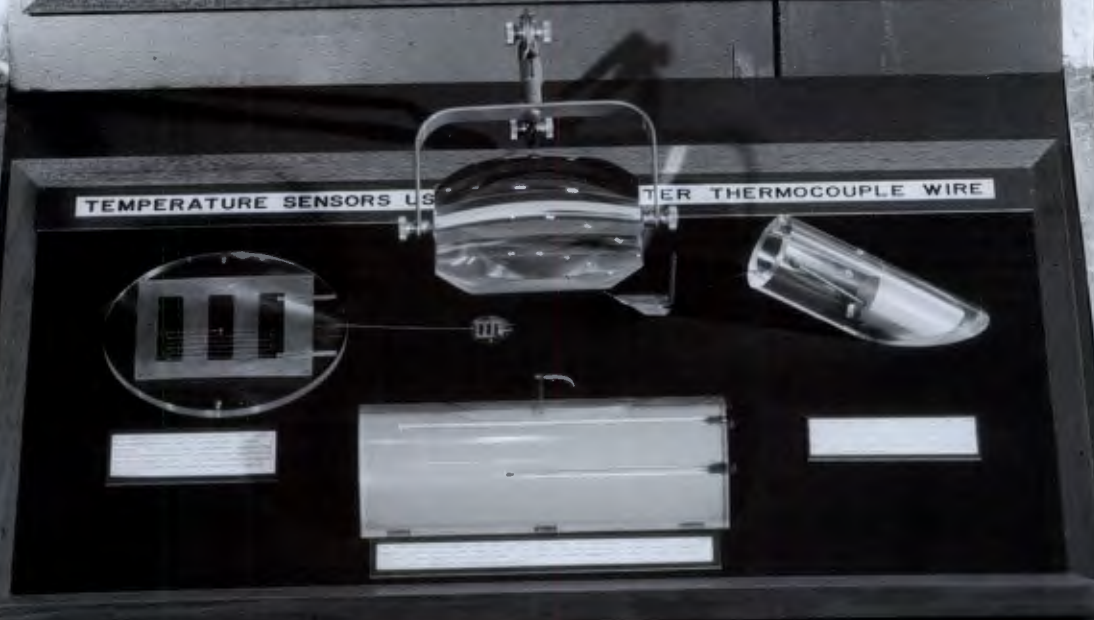
SENSORS FOR GAS TEMPERATURE & HEAT FLOW

NASA
L-84-5349

TOTAL TEMPERATURE PROBES

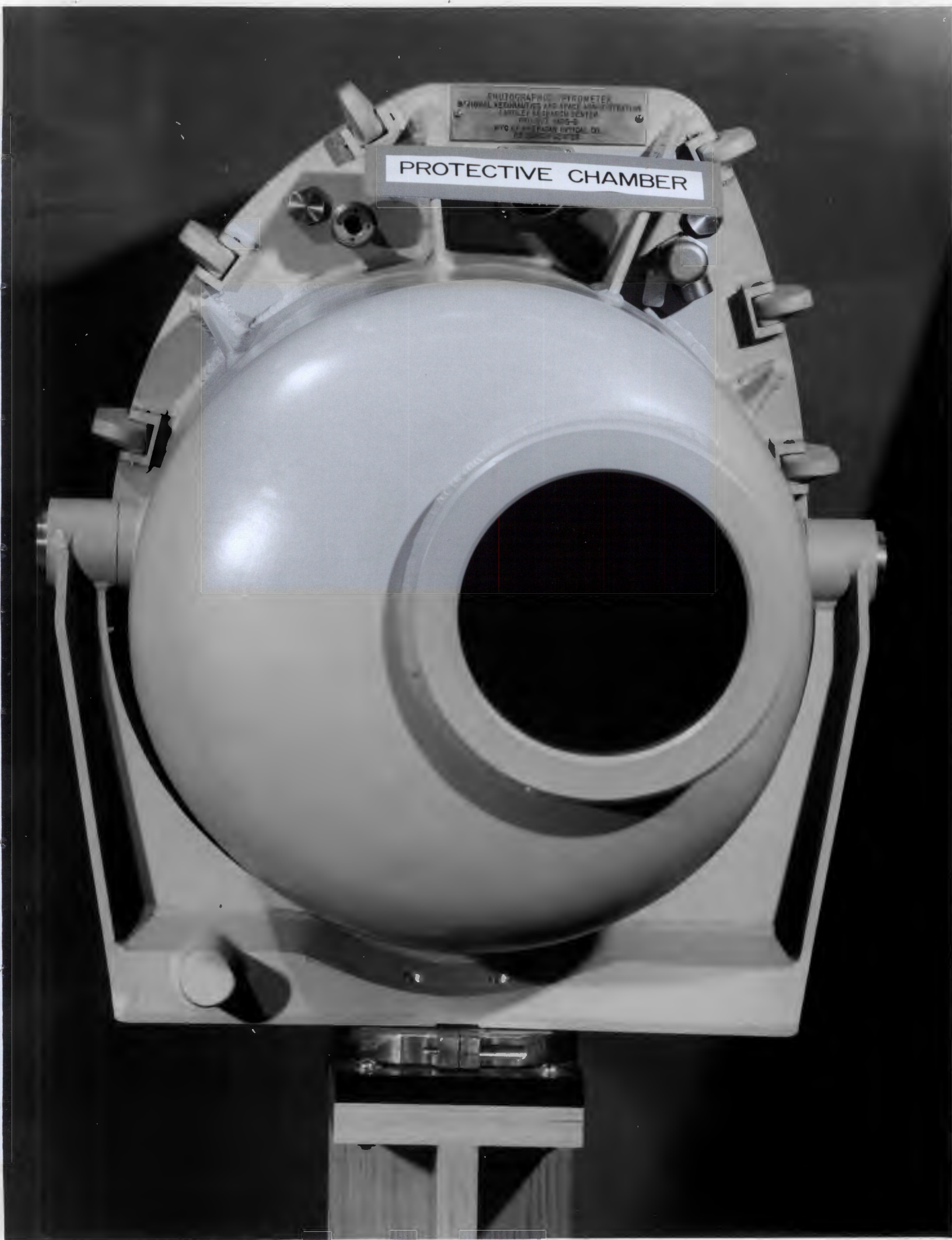


TEMPERATURE SENSORS USING THERMOCOUPLE WIRE

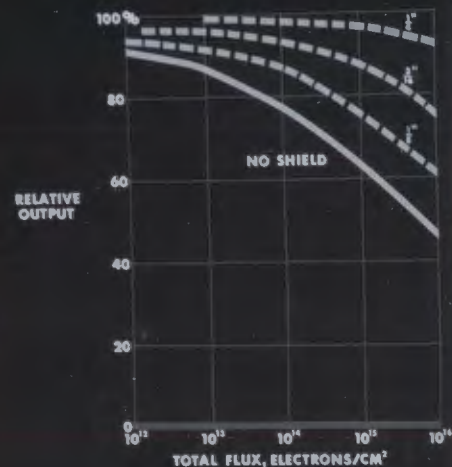


A7

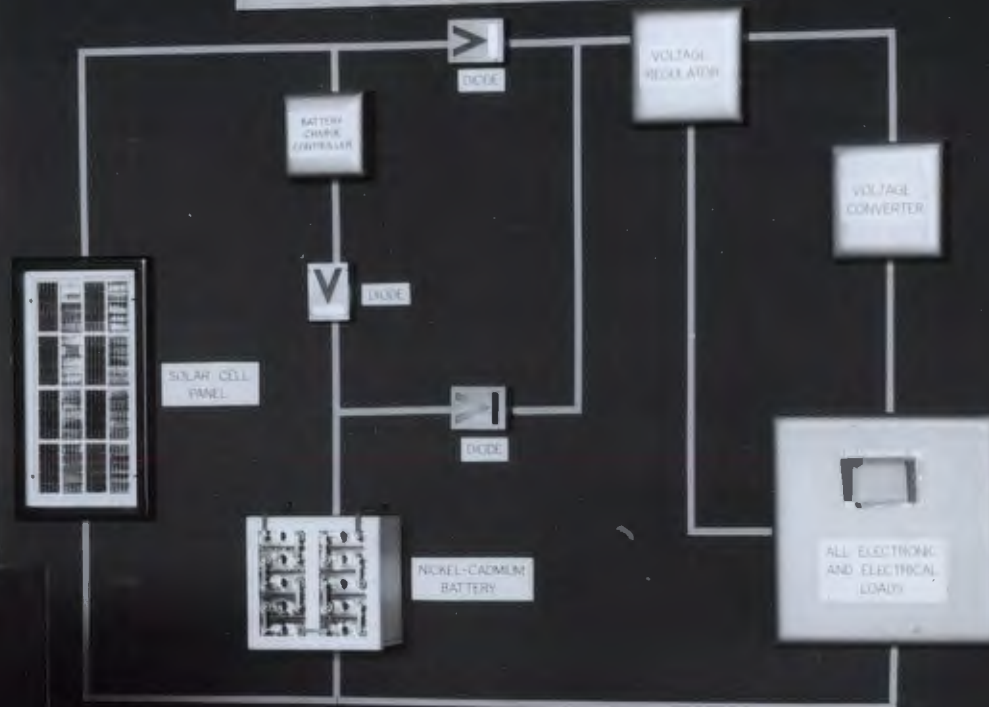
AND
WE



RADIATION DAMAGE RATES WITH AND WITHOUT SHIELDS: 2.4 MEV ELECTRONS



TYPICAL SOLAR CELL- BATTERY SPACE POWER SYSTEM



FEASIBILITY MODEL OF A DRY TAPE BATTERY



Small informational cards or labels placed near the battery models.

Small informational cards or labels placed near the battery models.

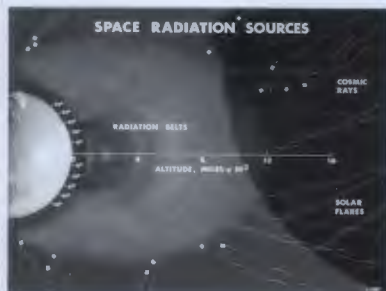
Small informational cards or labels placed near the battery models.

SPACE POWER SYSTEMS

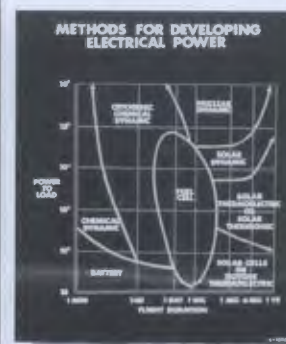
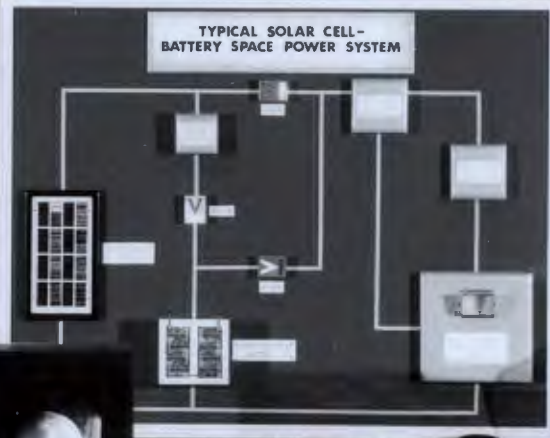
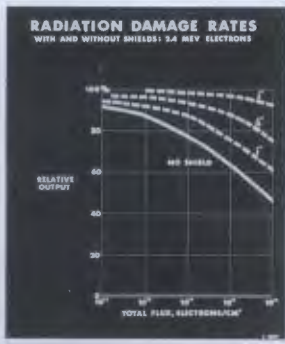
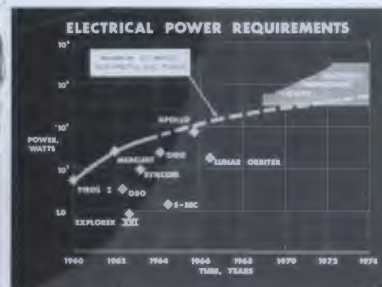
GENERATION — STORAGE — CONTROL

SOURCES: SOLAR — CHEMICAL — NUCLEAR

SOLAR CELLS ARE FREQUENTLY USED TO CONVERT SOLAR ENERGY TO ELECTRICITY. THEY ARE QUITE RELIABLE, BUT EITHER EXTRA CELLS OR SHIELDING MUST BE PROVIDED BECAUSE OF SPACE RADIATION.



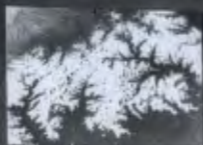
NEW-TYPE SYSTEMS ARE BEING DEVELOPED FOR FUTURE SPACE MISSIONS. THE OPTIMUM TYPE OF SYSTEM IS DEPENDENT ON TOTAL POWER REQUIREMENTS AND DESIRED MISSION LIFETIME.



MULTI-APERTURE ANTENNA UNDER STUDY

OBJECTIVE: TO INCREASE NASA'S DEEP SPACE COMMUNICATION CAPABILITY

EXAMPLE: FOR A TYPICAL SPACECRAFT TO TRANSMIT A PICTURE EQUIVALENT TO THIS ONE OF THE EARTH



	TRANSMISSION TIME
(1) FROM MARS USING PRESENT 85' RECEIVING ANTENNA REQUIRES	2 1/4 DAYS
(2) FROM MARS USING AN EFFECTIVE 480' RECEIVING ANTENNA REQUIRES	1 1/2 HOURS

TWO METHODS OF OBTAINING 480' EQUIVALENT DIAMETER ANTENNAS

- (1) INCREASE SIZE OF SINGLE STRUCTURE ANTENNA TO 480' DIA.
(NOT STATE OF THE ART AT THE HIGHER FREQUENCIES REQUIRED)
- (2) DEVELOP MULTI-APERTURE ARRAY BY (COHERENTLY COMBINING THE OUTPUTS
FROM A NUMBER OF INDEPENDENTLY STEERABLE ANTENNAS)
(LRC RESEARCH HAS ESTABLISHED FEASIBILITY OF THIS BASIC TECHNIQUE)

CONSIDERATIONS FOR MULTI-APERTURE ARRAY OVER SINGLE STRUCTURE ANTENNA

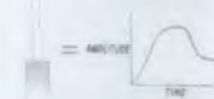
- (1) IMPROVED PERFORMANCE (OPERATION AT HIGHER FREQUENCIES WILL RESULT IN HIGHER GAIN)
- (2) GREATER FLEXIBILITY (CAN TRACK MULTIPLE TARGETS)
- (3) UTILIZES "STATE-OF-THE-ART" ANTENNAS
- (4) HIGHER OPERATIONAL RELIABILITY

MODEL OF MULTI-APERTURE ARRAY (16-120' ANTENNAS) EQUIVALENT TO MODEL OF SINGLE STRUCTURE 480' ANTENNA



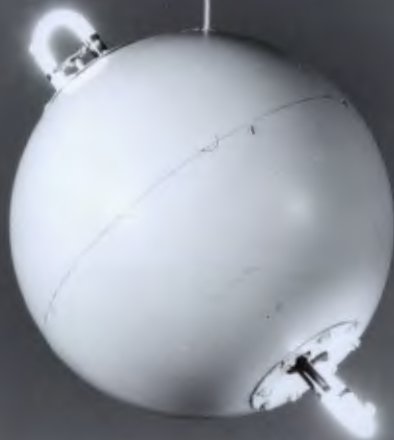
TO FIND THE ANSWER...

...THEY HAVE LEARNED THAT IMPACT CONDITIONS, SUCH AS AMPLITUDE AND TIME, ARE DEPENDENT ON THE MATERIAL IMPACTED.

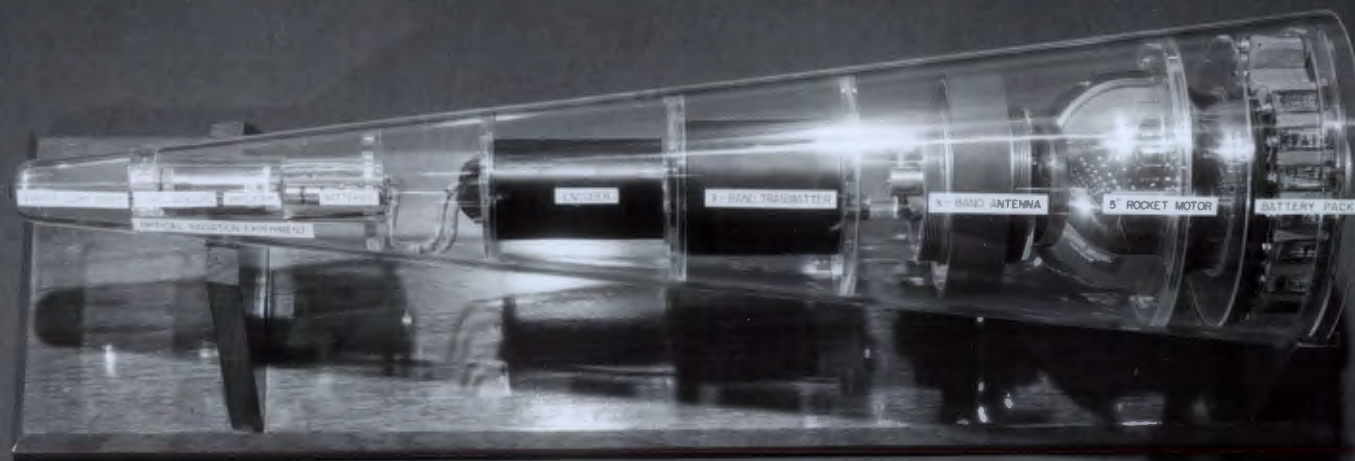


...VE HAVE BEEN SUC-
...NG GROUND TESTS
...PH

VOLCANIC



THE STROBE LIGHT ABOVE IS A FULL-SIZE MODEL OF A SIMILAR UNIT EJECTED FROM GORDON COOPER'S CAPSULE DURING THE THIRD ORBIT OF THE LAST MERCURY FLIGHT. THE EXPERIMENT WAS TO DETERMINE MAN'S ABILITY TO SEE SUCH LIGHTS IN SPACE. THIS INTERNALLY POWERED BEACON WAS DESIGNED TO FLASH ONCE EVERY SECOND FOR OVER 5 HOURS. THE SUB-SATELLITE WAS LAST SEEN BY ASTRONAUT COOPER THREE ORBITS LATER AT A DISTANCE OF OVER 12 MILES



MIN-X PAYLOAD

AN OPTICAL RADIATION
MEASUREMENT EXPERIMENT
USING A MINIATURE X-BAND
SUPER HIGH FREQUENCY
TELEMETRY SYSTEM TO
PENETRATE THE PLASMA
SHEATH

RAM

SOLUTIONS

ICAL AND EXPERI-
THE PROBLEMS OF
RAFT DURING RE-
PROGRAM IS VITAL
PACE MISSIONS



NEEDLE-NOSE SHAPE



SUPER-HIGH FREQUENCY



MAGNETIC WINDOW



MATERIAL ADDITION



RAM A

ES BOTH GROUND
O ANALYZE THE RE-
IBLE SOLUTIONS

THE FOUR SOLUTIONS SHOWN ABOVE HAVE BEEN SUC-
CESSFULLY DEMONSTRATED DURING GROUND TESTS
AND FLIGHT TEST AT SPEEDS UP TO 14,000

MODEL OF RAM B VEHICLE

RAM B-5 HOSE BONS



MICROWAVE



RADIOMETER - MEASURES
PLASMA RADIATION



UHF

HF

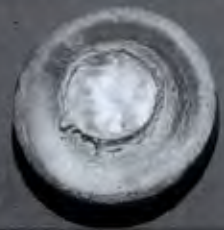
TRANSMITTERS—USED FOR
RADIO BLACKOUT MEASUREMENTS



IMPEDANCE RING - MEASURES
VHF ANTENNA CHARACTERISTICS

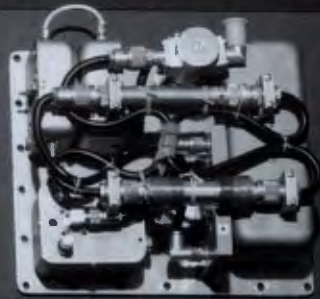


BEFORE TEST



AFTER TEST

MODEL USED FOR GROUND TESTING
REFLECTOMETER ANTENNA WINDOW



REFLECTOMETER - MEASURES
ELECTRON DENSITY OF PLASMA

EXPERIMENTAL EQUIPMENT
USED IN RAM PAYLOADS

PROJECT RAM

RADIO COMMUNICATION DURING REENTRY

RADIO BLACKOUT



OUTER SPACE - COMMUNICATIONS ARE NORMAL ABOVE THE EARTH'S ATMOSPHERE

REENTRY - FRICTIONAL HEATING DURING HIGH-SPEED ENTRY INTO THE ATMOSPHERE FORMS AN ENVELOPE OF IONIZED AIR (PLASMA) AROUND THE SPACECRAFT WHICH BLOCKS THE PASSAGE OF RADIO SIGNALS

LANDING - THE PLASMA DISAPPEARS AS THE SPACECRAFT SLOWS DOWN AND COMMUNICATIONS ARE RESTORED

LRC RESEARCH PROGRAM

PROJECT RAM IS A BROAD THEORETICAL AND EXPERIMENTAL PROGRAM TO INVESTIGATE THE PROBLEMS OF COMMUNICATING WITH A SPACECRAFT DURING REENTRY. INFORMATION FROM THIS PROGRAM IS VITAL TO BOTH MANNED AND UNMANNED SPACE MISSIONS



RAM 3

LABORATORY TEST

RAM 4

THE EXPERIMENTAL PHASE INVOLVES BOTH GROUND AND FLIGHT TESTS (FOUR TO DATE) TO ANALYZE THE REENTRY PLASMA AND EVALUATE POSSIBLE SOLUTIONS

SOLUTIONS



REENTRY - NOISE SHIELD



REENTRY - NOISE SHIELD



REENTRY - NOISE SHIELD



REENTRY - NOISE SHIELD

THE FOUR SOLUTIONS SHOWN ABOVE HAVE BEEN SUCCESSFULLY DEMONSTRATED DURING GROUND TESTS AND FLIGHT TESTS AT SPEEDS UP TO 14,000 MPH



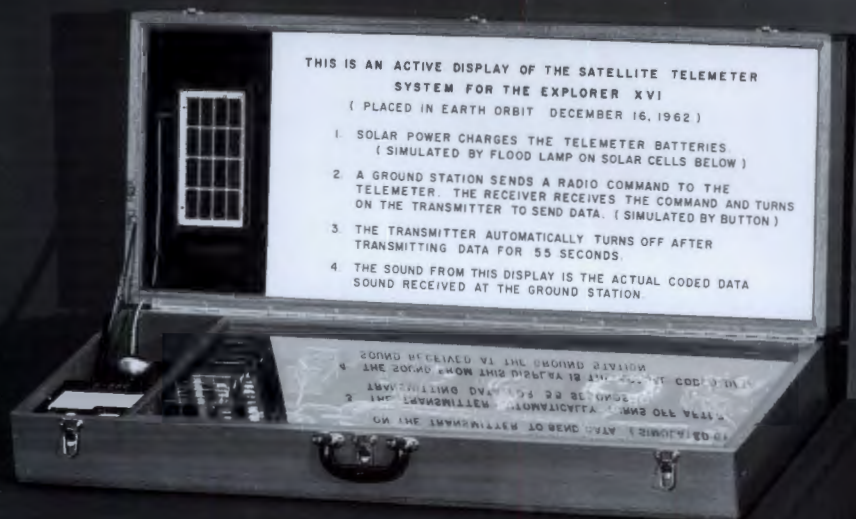
SATELLITE TELEMETRY SYSTEM

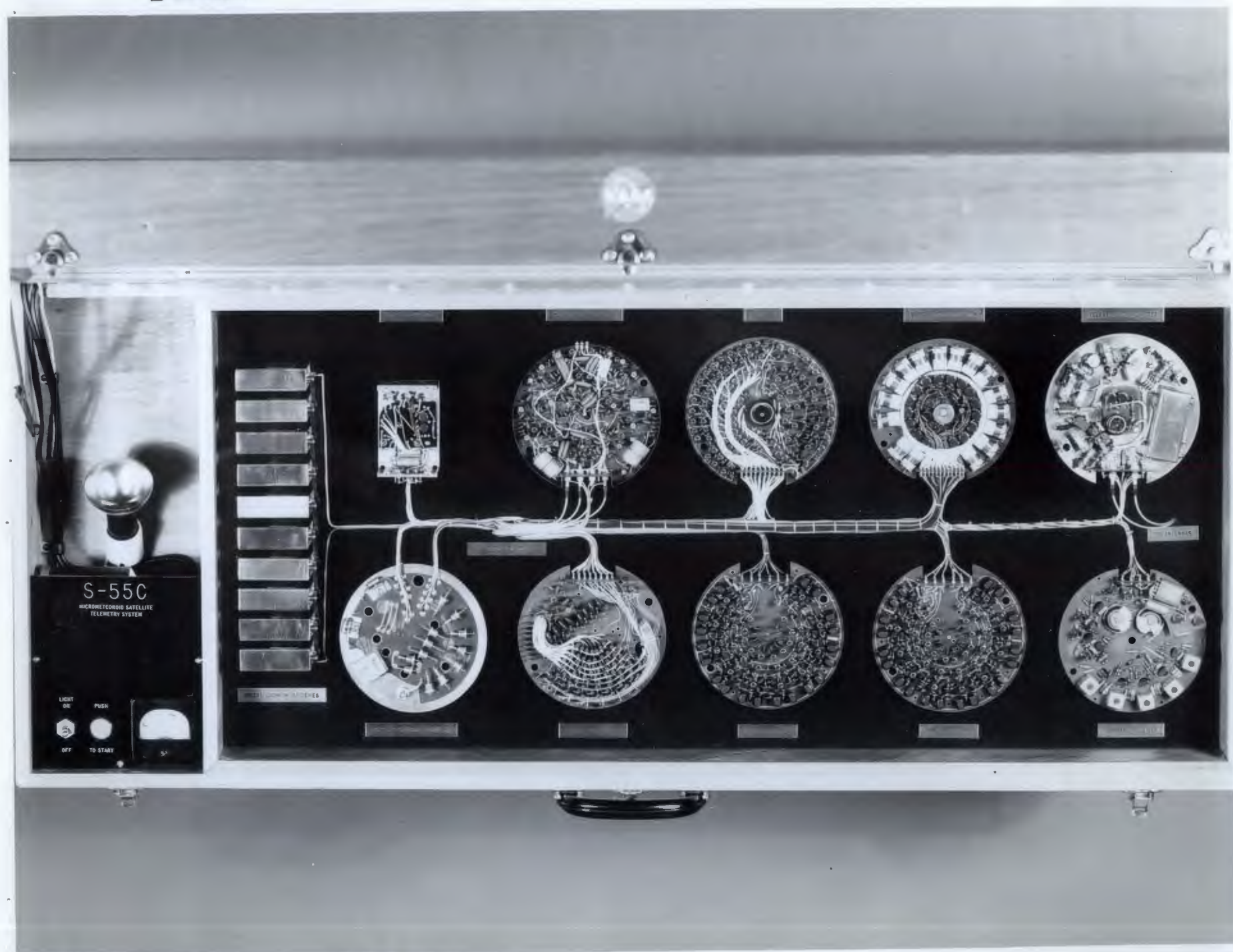
NASA
L-64-5325

CANNISTERS ARE FLIGHT PACKAGED
SATELLITE TELEMETRY SYSTEMS

A SINGLE CANNISTER

WEIGHTS 12.5 LBS.
VOLUME 273 CUBIC INCHES
HAS 48 DATA CHANNELS
HAS 1500 ELECTRONIC COMPONENTS





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L-64-5328



INFORMATION DISPLAY

1- PROBLEMS IN PRESENT DAY COCKPIT DESIGN

A. COMPLEXITY OF ADVANCED MISSIONS ARE CRITICALLY BURDENING MAN'S CONTROL AND DECISION ABILITY

B. SPECIFIC PROBLEMS:

1. COCKPIT CLUTTER AND REDUNDANCY
2. INSTRUMENT INFLEXIBILITY AND LIMITATIONS
3. INTERPRETATION ERROR AND REACTION TIME
4. DEVELOPMENTAL COSTS AND TIME LAG OF NEW INSTRUMENTS
5. INSTRUMENT VISION AND RELIABILITY



THE CLUTTERED COCKPIT

2- ADVANTAGES OF NEW TECHNIQUES

A. DISPLAY INTEGRATION
COMBINATION OF INDICATIONS IN AN INTEGRATED AND INTERRELATED FORMAT

B. DISPLAY TIME SHARING
REDUCES THE NUMBER OF COCKPIT INSTRUMENTS AND PROVIDES AUTOMATIC AND PILOT CONTROL OF DISPLAY FORMAT

C. PROGRAMING
ELECTRONIC, OPTICAL, AND PHOTOGRAPHIC TECHNIQUES ACHIEVE FLEXIBILITY

INTEGRATED DISPLAYS



RESEARCH PROGRAM

A. TITLE: UNIVERSAL ELECTRONIC DISPLAY SYNTHESIZING SYSTEM

B. OBJECTIVE: Provide Techniques and Knowledge for Optimum Display Panel Design for Advanced Manned Missions.

C. METHOD: Rapid Generation of Experimental Patterns and Symbols for Simulation Using methods Shown Below.

D. RESEARCH POTENTIAL:

1. Synthesis of New Display Formats at Higher Speeds at Lower Cost, and at More Advanced Levels.
2. Support of Existing Flight Simulation Facilities.
3. Research and Development of Advanced Electronic Devices and Techniques.



E. PROGRAM STATUS: System Presently Being Studied Projected Configuration Shown Below Left.

F. UNIQUE FEATURES:

1. Programming Methods Include Photography, Optics, and Electronic Techniques Shown Below Right.
2. Readout by High Resolution Closed Circuit Television Shown Below Center.
3. Automatic and Pilot Control of Display Format Shown by Switching Functions Below.

